Vol. 12, No. 10
May 31, 1987

# Energy Research Abstracts

Abstracts 19890-22082

Office of Scientific & Technical Information
UNITED STATES DEPARTMENT OF ENERGY

# CURRENT INFORMATION ON ENERGY

To provide immediate and complete coverage of literature related to major Department programs, the Office of Scientific and Technical Information provides an on-line retrieval system, data bases, and current-awareness publications. The Energy Data Base (EDB), which contains all unclassified, unlimited energy and nuclear related information processed by OSTI since 1974, and the Nuclear Science Abstracts Data Base (NSA), which covers nuclear information from 1948 through June 1976, are available for machine searching using commercial on-line retrieval systems. All information in the publications listed below, plus additional backup information, is included in the EDB. Current information being added to the EDB is available for on-line searching via the OSTI Automated Retrieval System (OARS) accessible to DOE and contractors through the Integrated Technical Information System (ITIS).

The publications described below and access to ITIS/OARS are available to Department of Energy and contractor components from the Office of Scientific and Technical Information, U. S. Department of Energy, P. O. Box 62, Oak Ridge, TN 37831/Telephone (615) 576-1301; FTS 626-1301.

## PUBLICATIONS OF THE OFFICE OF SCIENTIFIC AND TECHNICAL INFORMATION

***Energy Abstracts for Policy Analysis (EAPA)***

A monthly abstract journal devoted to the analysis of energy research, conservation, and policy. Scope and coverage are limited to substantive articles or reports and emphasize legislative, regulatory, and other legal aspects, as well as social, economic, and environmental impacts. *EAPA* is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The annual subscription price is $63.00 for domestic (North America) or $78.75 for foreign (outside North America) subscribers; a single issue is $6.00 or $7.50, respectively.

***Energy Research Abstracts (ERA)***

A comprehensive semimonthly abstract journal devoted to all areas of energy-related information produced by the Department of Energy, other U. S. government organizations, and foreign governments. *ERA* is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The annual subscription price for the 24 issues is $146.00 for domestic (North America) subscribers or $182.50 for foreign (outside North America) subscribers. A single issue is $14.00 or $17.50, respectively.

***DOE Patents Available for Licensing (PAL)***

DOE is prepared to grant exclusive or nonexclusive, revocable licenses under DOE-owned U. S. patents and patent applications; this semiannual publication provides abstracting and indexing coverage of this literature. *PAL* is available as PB87-946800 from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161 on a standing order basis through an NTIS Deposit Account. To establish an NTIS account, send the minimum $25.00 deposit to NTIS, Attn: Customer Accounts. A single issue is $12.00 for domestic (North America) and $24.00 for foreign (outside North America).

***Energy Meetings (EM)***

A monthly listing of conferences, symposia, workshops, etc., pertaining to DOE's programmatic interests. *EM* is available on subscription (use PB87-901500) from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. The annual subscription price is $70.00 for domestic subscribers and $140.00 for subscribers outside the North American continent; a single issue is $8.00 and $16.00, respectively.

The following semimonthly bulletins are also available from the National Technical Information Service. The annual subscription rate for one volume (calendar) year (24 issues; no indexes) is $80.00 for domestic (North America) and $160.00 for foreign (outside North America) subscribers; use the identifying order number (PB- No.) when subscribing.

***Acid Precipitation (APC)*–PB87-901000.** Acid precipitation, including effects and possible control measures.

***Buildings Energy Technology (BET)*–PB87-900700.** Technology required for energy conservation in buildings of all types.

***Coal-Based Synfuels (CBS)*–PB87-901400.** Conversion of coal into gaseous or liquid fuels.

***Coal Combustion and Utilization (CCU)*–PB87-914400.** Coal combustion, including fluidized bed combustion, and direct utilization of coal for power generation, fuel cells, and MHD generators.

***Coal Preparation and Pollution Control (CPC)*–PB87-900800.** Coal preparation and cleaning and reducing pollution from its direct combustion.

***Direct Energy Conversion (DEC)*–PB87-946600.** Photovoltaics, magnetohydrodynamics, electrohydrodynamics, thermoelectrics, thermionics, and fuel cells.

***Energy from Biomass (EFB)*–PB87-900600.** Biomass production, conversion, and utilization for energy.

***Geothermal Energy Technology (GET)*–PB87-914700.** Exploration, development, and utilization of geothermal resources.

***Heavy-Ion Reactions (HIR)*–PB87-900500.** Heavy-ion (A > 4) reactions.

***Laser Research (LAR)*–PB87-901100.** Laser research and development, excluding applications.

***Nuclear Fuel Cycle (NFC)*–PB87-913400.** Both front and back ends of the nuclear fuel cycle.

***Nuclear Reactor Safety (NRS)*–PB87-913500.** Accident analysis, safety systems, radiation protection, decommissioning and dismantling, and security measures.

***Radioactive Waste Management (RWM)*–PB87-902900.** Management aspects of transport and storage, waste processing, waste disposal, waste storage, radioactive effluents, and shipping containers.

***Solar Thermal Energy Technology (STT)*–PB87-901200.** Research and development of efficient and reliable solar thermal conversion systems.

***Transportation Energy Research (TER)*–PB87-900900.** Energy-efficient advanced automotive propulsion systems and transportation energy conservation.

***Unconventional Petroleum (UCP)*–PB87-901300.** Secondary and tertiary recovery of petroleum and oil shales and tar sands.

## INTERNATIONAL ENERGY PUBLICATIONS

The Office of Scientific and Technical Information (OSTI) cooperates in the publication of international abstract journals with the following: (1) International Atomic Energy Agency, International Nuclear Information System, Vienna, Austria, for *Atomindex;* (2) International Energy Agency, Biomass Conversion Technical Information Service, Dublin, Ireland, for *Biomass Abstracts;* and (3) International Energy Agency, IEA Coal Research, London, England, for *Coal Abstracts.* In each case, the cognizant foreign agency provides the non-U. S. information to OSTI for inclusion in the Energy Data Base; in turn, OSTI provides the U. S. information for input into the respective journal.

***Atomindex***

A semimonthly abstract journal providing worldwide coverage of information on nuclear science and technology. *Atomindex* is available by subscription from Bernan Associates—UNIPUB, 10033-F King Highway, Lanham, MD 20706. The cost of an annual subscription, 24 semimonthly issues and semiannual and annual cumulative indexes, is $355.

***Biomass Abstracts***

A bimonthly abstract journal with comprehensive coverage of information on the conversion of biomass to energy. *Biomass Abstracts* is available free to DOE components and contractors from OSTI. Non-DOE organizations may obtain *Biomass Abstracts* from Biomass Conversion Technical Information Service, Institute for Industrial Research and Standards, Ballymun Road, Dublin 9, Ireland, for 60 IR pounds per year for participating countries and 90 IR pounds per year for nonparticipating countries. Make checks payable to the Institute.

***Coal Abstracts***

A monthly abstract journal providing comprehensive worldwide coverage of information in the field of coal science and technology. *Coal Abstracts* is available to DOE components and contractors from OSTI. Non-DOE organizations may obtain *Coal Abstracts* from IEA Coal Research, Technical Information Service, 14-15 Lower Grosvenor Place, London SW1W 0EX, England, for 110 pounds sterling per year.

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# ENERGY RESEARCH ABSTRACTS

## ABOUT THE OFFICE OF SCIENTIFIC AND TECHNICAL INFORMATION

The Office of Scientific and Technical Information (OSTI) in Oak Ridge, Tennessee, has been the national center for scientific and technical information for the Department of Energy (DOE) and its predecessor agencies since 1946. In developing and managing DOE's technical information program, OSTI places under bibliographic control not only DOE-originated information but also worldwide literature on scientific and technical advances in the energy field and announces the source and availability of this information. Although the literature of science is emphasized, coverage extends to DOE programmatic, socioeconomic, environmental, legislative/regulatory, energy analysis, and policy-related areas. To accomplish the mission of furnishing centralized support for Departmental elements in managing their scientific and technical information, OSTI builds and maintains computerized data bases and disseminates information via computerized retrieval systems and announcement publications such as abstract journals, bibliographies, and bulletins. Direct access to OSTI's Energy Data Base (EDB) and Nuclear Science Abstracts Data Base (NSA) is available to the U. S. scientific community through commercial on-line retrieval systems. Access to these data bases from outside the United States is available only through formal exchange agreements. The current-year EDB records, DOE Research-In-Progress, and various other specialized DOE data bases are available to DOE offices and contractors and other government agencies through the OSTI Automated Retrieval System (OARS), which is a major component of the Integrated Technical Information System (ITIS). In addition to providing access to the OSTI on-line systems, ITIS serves as a gateway to other government and commercial systems and provides information merging for customized information products. The Office of Scientific and Technical Information has developed systems to record and communicate energy-related research-in-progress information, to track research report deliverables from DOE contractors, to test and make available DOE-funded computer software programs with scientific and management applications, and to produce special publications in support of DOE program offices. To manage DOE's technical information resources effectively, OSTI's program is one of continual development and evaluation of new information products, systems, and technologies.

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## ABOUT *ENERGY RESEARCH ABSTRACTS*

*Energy Research Abstracts (ERA)* provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U. S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. The user should remain aware that *ERA* coverage of non-report literature is limited to that generated by Department of Energy activity.

*ERA* is comprehensive in its subject scope, encompassing the DOE's research, development, demonstration, and technological programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

*ERA* is available on an exchange basis to universities, research institutions, industrial firms, and publishers of scientific information. Inquiries should be directed to the Office of Scientific and Technical Information, P. O. Box 62, Oak Ridge, TN 37831.

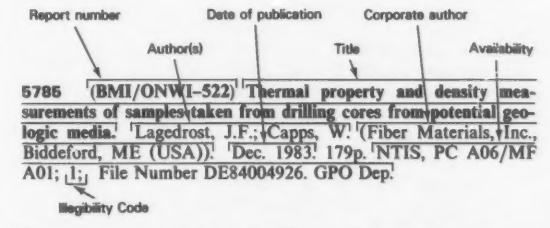
*ERA* is available to the public on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The subscription rate for the 24 semimonthly issues is $146.00 for domestic subscribers and $182.50 for foreign subscribers. A single issue costs $14.00 (domestic) or $17.50 (foreign). The cumulative indexes will be available in printed form from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402, and in microfiche form from the National Technical Information Service, U. S. Department of Commerce, Springfield, VA 22161.

**Office of Scientific and Technical Information**
**United States Department of Energy, P. O. Box 62, Oak Ridge, TN 37831**

# HOW TO USE *ENERGY RESEARCH ABSTRACTS*

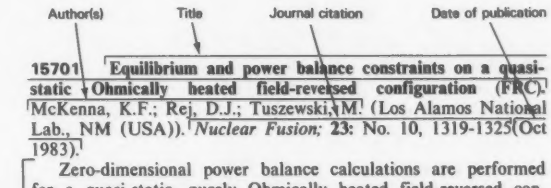
## ABSTRACTS IN *ENERGY RESEARCH ABSTRACTS*

The principal elements of abstract entries for a typical research and development report and a typical technical journal article are illustrated below.


Report number
Author(s)
Date of publication
Corporate author
Title
Availability
5785 (BMI/ONWI-522) Thermal property and density measurements of samples taken from drilling cores from potential geologic media. Lagedrost, J.F.; Capps, W. (Fiber Materials, Inc., Biddeford, ME (USA)). Dec. 1983. 179p. NTIS, PC A06/MF A01; 1; File Number DE84004926. GPO Dep.
Illegibility Code

Abstract

Density, steady-state conductivity, enthalpy, specific heat, heat capacity, thermal diffusivity and linear thermal expansion were measured on 59 materials from core drill samples of several geologic media, including rock salt, basalt, and other associated rocks from 7 potential sites for nuclear waste isolation. The measurements were conducted from or near to room temperature up to 500°C, or to lower temperatures if limited by specimen cracking or fracturing. Ample documentation establishes the reliability of the property measurement methods and the accuracy of the results.


Author(s)
Title
Journal citation
Date of publication
15701 Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC). McKenna, K.F.; Rej, D.J.; Tuszewski, M. (Los Alamos National Lab., NM (USA)). Nuclear Fusion; 23: No. 10, 1319-1325 (Oct 1983).

Abstract

Zero-dimensional power balance calculations are performed for a quasi-static, purely Ohmically heated field-reversed configuration. Without compression, the constraint imposed by radial pressure balance limits the power input. Estimates of the energy loss from impurity line radiation as well as from classical and anomalous transport are given. Effects of cold puff gas injection are also investigated.

## INDEXES TO *ENERGY RESEARCH ABSTRACTS*

Five indexes are provided for approaching the contents of each issue of *Energy Research Abstracts (ERA)*. Each index is preceded by an introduction that details the organization of the index and the principles by which it was compiled. The reader is referred to these introductions for information not found in the index examples that follow.

### • Corporate Author Index

Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

5785 (BMI/ONWI-522) Thermal property and density measurements of samples taken from drilling cores from potential geologic media. Lagedrost, J.F.; Capps, W. **(Fiber Materials, Inc., Biddeford, ME (USA)).** Dec. 1983. 179p. NTIS File Number DE84004926. GPO Dep.

is indexed as:

**Fiber Materials, Inc., Biddeford, ME (USA)**

### • Personal Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

**Capps, W.,** *See* Lagedrost, J. F.
**Lagedrost, J.F.,** Thermal property and density measurements of samples taken from drilling cores from potential geologic media, 9:5785 (R;US)
**McKenna, K.F.,** Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC), 9:15701 (J;US)
**Rej, D.J.,** *See* McKenna, K.F.
**Tuszewski, M.,** *See* McKenna, K.F.

### • Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

**SALT DEPOSITS**
**Density**
Thermal property and density measurements of samples taken from drilling cores from potential geologic media, 9:5785 (R;US)
**REVERSED-FIELD PINCH**
**Energy Balance**
Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC), 9: 15701 (J;AT)

### • Contract Number Index

DOE technical report literature is indexed using contract numbers. This index contains the contract number with corresponding abstract and report numbers.

| | | |
|---|---|---|
| **AC06-76RL01830** | **Fiber Materials, Inc., Biddeford, ME (USA)** | |
| | 9:5785 | BMI/ONWI-522 |

### • Report Number Index

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. Patents and conference papers are indexed here as a matter of convenience. When a report is supplied under a File Number, that number is included in the availability statement. A file number–report number correlation is included for convenience.

| | | |
|---|---|---|
| **BMI/ONWI-522** | 9:5785 | NTIS, PC A09/MF A01. File Number DE84004926, Distribution Category MN-70 |

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**Foreign Sources**

CEA Centre d'Etudes de Saclay
GIF-sur Yvette Cedex, France

Fachinformationszentrum
Energie, Physik, Mathematik GmbH
Karlsruhe, Federal Republic of Germany

IEA Biomass Conversion Service
Dublin, Ireland

IEA Coal Research
Technical Information Service
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Nordic Energy Libraries
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Roskilde, Denmark

Research Center
Netherlands Energy Research Foundation
Petten, Holland

United Kingdom of Great Britain and Northern Ireland
Department of Energy
London, England

**U. S. Sources**

American Institute of Physics
New York, NY

Department of Commerce
National Technical Information Service
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Information Management Services, Inc.
Oak Ridge, TN

National Aeronautics and Space Administration
Scientific and Technical Information Division
Springfield, VA

National Institutes of Health
National Library of Medicine
Bethesda, MD

NOVA Information Services Company
Commack, NY

Communication concerning the editorial policy and content of *Energy Research Abstracts* should be addressed to the Editor, *Energy Research Abstracts,* Office of Scientific and Technical Information, P. O. Box 62, Oak Ridge, TN 37831.

# SUBJECT CONTENTS (NUMERICAL LISTING)

Six-digit subject category numbers are used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's computerized bibliographic information system. The six-digit category numbers are utilized as if they were three pairs of two-digit numbers, the first two pairs being used to arrange the abstract content of *Energy Research Abstracts*. The following listing includes the totality of the 41 first-level and 276 second-level subject categories used. Because each issue of *ERA* announces only those documents becoming available during a semimonthly period, some subject categories may not be represented in every issue. The complete subject category scheme with scope definitions and limitations is available as DOE/TIC-4584-R6 from NTIS for $9.50.

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# ENERGY RESEARCH ABSTRACTS

## 01 COAL AND COAL PRODUCTS

### 0103 Preparation

*REFER ALSO TO CITATION(S) 19929, 19935, 19940, 19941, 19954, 19963*

**19890 (BNL—39196) Determination of the effect of carbon dioxide/water on physical and chemical properties of coal: Final report.** Trinidad-Coughlan, R.; Sapienza, R.S.; Butcher, T.; Healy, F. (Brookhaven National Lab., Upton, NY (USA)). Jan 1986. Contract AC02-76CH00016. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006461.

A process for the simultaneous cleaning and fracturing of a variety of coals using a pressurized carbon-dioxide and water solvent system has been explored by Brookhaven National Laboratory. This technique was implemented in batch-wise reactions to characterize its effect on test coals provided by Florida Power and Light to achieve coal ash reduction and improved grinding behavior. Pressure, temperature, and reaction times were key parameters studied for suitable integration with coal slurry transport applications. Coal particles sized between 0.6 to 1.12 mm were utilized for initial tests. Key results demonstrate that: (1) breakage rates were increased for treated coal, resulting in improved grinding performance, (2) reductions in total ash content for treated coals were observed, although no selectivity in mineral matter removal was noted, and (3) contact times of one-half hour were sufficient in effecting coal changes; mild temperatures, and high $CO_2$ pressure combinations were favored reaction conditions. Slurry pipeline effects, such as the role of the inherent mechanical mixing and comminution of the coal, were tested in an agitated reactor system pressurized with $CO_2$/water. Mixing did not appear to greatly influence coal reactivity, suggesting that mass transport effects are not important for the type and size of coal used. Coal comminution resulted from mechanical agitation of the slurry, and increased comminution was observed under a $CO_2$/water atmosphere. The feasibility of directly preparing a coal-water slurry with the $CO_2$/water treatment combined with a comminution step was tested. Experiments on an integrated reactor/grinder suggest an increased breakage rate for coal exposed to pressurized $CO_2$. The possibility of using $CO_2$/water treatments to achieve coal beneficiation, while preparing coal for slurry pipeline transportation may offer potential advantages. 5 refs., 15 tabs.

**19891 (BNL—39264) Introducing coal-water mix fuels.** Butcher, T.A.; Krishna, C.R.; Sapienza, R.S.; O'Hare, T.E.; Celebi, Y. (Brookhaven National Lab., Upton, NY (USA)). Jan 1986. Contract AC02-76CH00016. 16p. (CONF-860106—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006464.

From ASHRAE semi-annual meeting; San Francisco, CA, USA (19 Jan 1986).

General considerations associated with the formulation and use of coal-water fuels (CWF) in heating applications are discussed in this overview. Selection of coal for CWF involves consideration of coal volatiles, heating value, ash composition and content, and equilibrium moisture. Additives that can be used to modify the fuel mix properties include dispersants, pH modifiers, stabilizers, and biocides. The flow properties of the formulations produced are non-Newtonian (both time-dependent viscosity (thixotropic) and shear rate dependent viscosity). Pressure drops in piping systems are, however, still predictable and some discussion of techniques and results is included. The carrier water in CWF leads to reduced boiler efficiency, lowered flame temperatures, and increased boiler flue gas flow. The magnitude of these effects is quantified as a function of fuel water content. Approaches toward achieving flame stability are also discussed. BNL's combustion experience with boiler systems in the 1,000,000 Btu/h size class is reviewed. Studies have included moderately loaded slurries, highly loaded slurries, oil cofiring, and combustion air preheat. 4 refs., 5 figs., 2 tabs.

**19892 (EPRI-CS—4994) Combustion characterization of the Kentucky No. 9 cleaned coals: Final report.** Chow, O.K.; Lexa, G.F. (Combustion Engineering, Inc., Windsor, CT (USA). Power Systems Div.; Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 206p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920272.

A comprehensive research program was conducted to assess the merits of coal cleaning as a means of improving utility boiler operation. This program involved detailed bench and pilot scale assessment of pulverization, combustion, furnace slagging, convective pass fouling, emissions and fly ash erosion characteristics of a Kentucky No. 9 baseline coal and its medium cleaned and deep cleaned products. Test results were applied, using Combustion Engineering's (C-E) in-house computer models, to predict the performance of a 350 MW utility boiler and its auxiliary equipment using the cleaned coals. Results indicated that cleaning had a beneficial effect on nearly all areas of fuel performance. The reduction in ash quantity due to cleaning significantly improved pulverization in terms of grinding energy requirement and reduction in fuel abrasion/mill wear. Fly ash erosion decreased significantly with increased cleaning at equivalent operating conditions which could result in longer convection tube life. The lower sulfur content of the cleaned coals reduced sulfur dioxide emission control requirement. Furnace slagging characteristics showed improvement for the cleaned coals. Waterwall deposits developed from each coal were thin and molten. The critical pilot-scale test conditions for cleanable deposits were at a 3.2 MBtu/hr fuel firing rate and a flame temperature of 2810°F for the baseline coal. These critical conditions increased to a firing rate of 3.4 MBtu/hr and a flame temperature of 2830°F for the cleaned coals, indicating a potential for operating at higher loads in a commercial furnace. Fouling characteristics also improved with increased coal cleaning. The lower ash loading of the cleaned coals decreased ash deposition rates, resulting in lower soot blowing requirements.

**19893 (ECE—COAL/GE.4/R.29/Add.8) Consideration of the activities of the National Mining Research Institutes of ECE countries and exchange of scientific, technical and economic information relating to the coal industry.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 11 Mar 1986. 10p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

In Czechoslovakia, research into underground and opencast mining and the utilisation of coal and lignite is conducted at research institutes which are organised into research institutes directly controlled by the Federal Ministry of Fuel and Energy, and research institutes under direct control of coal mining organisations. The first category of research institutes includes the following: the Mining Research Institute at Ostrava-Radvanice which has been researching into underground geomechanics, winning technology, ventilation and air conditioning, labor hygiene and safety, coal preparation and testing methods; the Research Institute of the Fuel and Energy Complex in Prague; the Fuel Research and Utilization Institute, Prague-Bechovice, the Brown Coal Research Institute in Most; the Mining Research Institute at Prievidza with the Coal and Lignite Mining Concern, Prievidza.

19894 **(ECE—COAL/GE.4/R.29/Add.2) Activities of the National Mining Research Institutes of ECE countries and exchange of scientific, technical and economic information relating to the coal industry.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 20 Jan 1986. 6p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper lists the eight different units, the majority of which are self-financing, that carried out the scientific research work for the coal industry in 1983-1984 in Poland. However the main body of the paper lists the fields that the research occurred in and the tasks carried out. These fields are as follows: new technology of exploitation and drivage of workings; mechanization of mining operations; support of workings; electrification and automation of mining production processes; combating of mining hazards; health protection and improvement of working conditions; surface and environment protection; utilization of wastes; preparation and conversion of coal; technical designs and documentation and computer science in the mining industry. The basic forms of scientific-technical cooperation with foreign countries and future plans of the scientific research units are also outlined.

19895 **(ECE—COAL/GE.4/R.22/Add.5/Sup.1) Authority and responsibility of advisory bodies and project assessment procedures to support decisions on research and development priorities and programmes.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 18 Nov 1985. 4p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper considers the research targets up to the year 1990 and beyond decreed by the Czechoslovakian government. The principle areas are subdivided as follows: basic research directed by the Czechoslovak Academy of Sciences; applied economic research directed by the economic research council; scientific and technical development of the national economy. The third area is further divided into specific state programmes for the development of science and technology, state scientific and technical programmes for solving current problems in the sector and individual scientific and technical assignments of authorities, concerns and undertakings. A decree of the Ministry of Fuel and Power defines the main areas of development of solid fuel research within the specific state programme and the overall plan of technical development the fuel and modernization of the coal industry. The areas of development are power sector, winning and preparation of coal in underground mines, opencast coal mining and preparation, use of solid fuel and gas, environmental protection and mining machinery and equipment for underground working.

## 0104 Processing

*REFER ALSO TO CITATION(S) 19915, 19918, 19935, 19940, 20164, 20311, 20509, 21064, 21278*

19896 **(DOE/FE/05081—2197-Vol.1) Coal gasification via the Lurgi process: Topical report: Volume 1, Production of SNG [substitute material gas].** Zahnstecher, L.W. (Foster Wheeler Corp., Livingston, NJ (USA)). Sep 1984. Contract AC21-82FE05081. 439p. NTIS, PC A19/MF A01; 1; GPO Dep. File Number DE87001008.

A Lurgi baseline study was requested by the DOE/GRI Operating Committee of the Joint Coal Gasification Program for the purpose of updating the economics of earlier Lurgi coal gasification plant studies for the production of substitute natural gas (SNG) based on commercially advanced technologies. The current study incorporates the recent experience with large size Lurgi plants in an effort to improve capital and operating costs of earlier plant designs. The present coal gasification study is based on a mine mouth plant producing 250 billion Btu (HHV) per day of SNG using the Lurgi dry bottom coal gasification technology. A Western subbituminous coal was designated as the plant food, obtained from the Rosebud seam at Colstrip, Montana. This study presents the detailed description of an integrated facility which utilizes coal, air, and water to produce 250 billion Btu (HHV) per day of SNG. The plant consists of coal handling and preparation, twenty-six Lurgi dry bottom gasifiers, shift conversion, acid gas removal, methanation, compression and drying of product gas, sulfur recovery, phenol and ammonia recovery, as well as necessary support facilities. The plant is a grass roots, mine mouth facility located in a Western location similar to the town of Colstrip in Rosebud County, Montana. The Lurgi Corporation assisted in this study, under subcontract to Foster Wheeler, by supplying the heat and material balances, flow sheets, utilities, catalysts and chemical requirements, and cost data for Lurgi designed process sections. Details of material supplied by Lurgi Corporation are presented in Appendix A. 52 refs., 36 figs., 64 tabs.

19897 **(DOE/FE/60177—2289) Postburn evaluation of the Hanna IV A and B UCG [underground coal gasification] experiments, Wyoming.** Oliver, R.L.; Sinks, D.J.; Berdan, G. (Western Research Inst., Laramie, WY (USA)). Jun 1986. Contract FC21-83FE60177. 93p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87006392.

Data from process monitoring, geophysical surveys, and postburn core studies were integrated to delineate the extent of affected coal and overburden at the Hanna IV A and B underground coal gasification experiment sites in southeastern Wyoming. The experiments were conducted from December 1977 to September 1979 in the Hanna No. 1 coal bed of the Eocene Hanna Formation. A postburn coring and well logging program was initiated in the fall of 1983. Well locations were selected using cavity boundary predictions determined by process monitor wells, a high-resolution seismic survey (June 1983). Detailed coal and overburden core studies were completed, including petrographic and scanning electron microscopy, X-ray analyses, strength tests, maceral analyses, vitrinite reflectance, fluorescence analyses, and proximate analyses. The Hanna IV A and B experiments apparently produced two distinct, temperature-stratified cavities separated by a fault zone of minor total displacement. Maximum coal consumption occurred near the west end of the IV A pattern, producing an asymmetrical cavity. Overburden collapse reached 45 ft. (14 m) above the top of the coal seam. Zones of maximum roof collapse are commonly bounded by minor faults that act as planes of weakness along which overburden fails. Override was a significant problem at the IV B pattern, primarily caused by faulting. A high percentage of calcite cement and sufficient porosity in the overburden contributed to limited roof collapse away from the faults. High-temperature mineral assemblages and fluorescence spectral parameters indicate that burn temperatures exceeded 2191°F (1200°C). The zone of reaction apparently is narrow (~6 in. [0.15 m]). 41 refs., 28 figs., 6 tabs.

19898 **(DOE/MC/20685—2263) Studies of initial reaction steps in the gasification of coal: Final report, October 1983-September 1985.** Chu, C.J.; Cannon, S.A.; Hauge, R.H.; Margrave, J.L. (Rice Univ., Houston, TX (USA). Dept. of Chemistry). 1985. Contract AC21-83MC20685. 140p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87001054.

This research has utilized matrix isolation FTIR and EPR for characterization of volatilized coal products. Both slow and rapid heating studies were carried out on four coals, Illinois No. 6, Pittsburgh bituminous, Rawhide sub-bituminous and Texas lignite. Pyrolysis products have been correlated to coal type and initial coal composition. Evolution of both a low and high temperature form of tar has been observed. Methylation of the hydroxyl structure in coal enhances the evolution of the low temperature form. Only the high temperature tar is found to contain free radical character. Significant temperature dependent evolution of CO, $CO_2$, $H_2O$, $H_2S$, $CS_2$, CS, HCN, $C_2H_4$, and $CH_4$ is observed and interpreted in terms of reaction mechanisms which occur during pyrolysis. Reaction of kaolinite with char is observed at high temperatures (1150 to 1500°C) to form volatile species SiO, $Al_2O$, and aluminum atoms. Significant evolution of the methyl free radical was observed for the first time. This observation strongly implies that direct bond dissociation of existing methyl groups in coal is a major reaction mechanism leading to methane formation. Infrared spectra of the matrix isolated tar has shown that only the phenolic hydroxyl group remains in the tar after vaporization. Studies of methylation of the hydroxyl groups present in coal with a deuterated

methyl group have allowed the identification of three distinct hydroxyl sites. They have been identified as carboxyl, phenolic and alcoholic in character. EPR spectra of the matrix isolated tars have shown significantly increased detail as compared to the respective coals. The spectra indicate that the free radical sites in the tars are delocalized over aromatic rings. Four different types of free radical species are observed and are tentatively associated with aromatic rings which contain no heterocycles as well as those with sulfur, nitrogen, and oxygen. 12 refs., 47 figs., 17 tabs.

19899 **(DOE/MC/21315—2169) Pretreatment techniques for coal gasification. Fourth quarterly report, July 1-September 30, 1985.** Graff, R.A. (City Coll., New York (USA)). 1985. Contract AC21-84MC21315. 33p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86016023.

Pretreatment of coal in steam is being explored with the goal of improving the economic attractiveness of coal gasification by cogeneration of light liquid fuels. A literature survey has been completed and submitted to DOE for review. Workers in the field, as well as the available literature, were surveyed for information on the design, construction and operation of dry coal feeders. Based on this information, a linear feeder was selected, designed, and constructed. In a series of off-line tests, modifications were made and tentative operating procedures established. The feeder was then installed on the reactor system and tested under operating conditions. The desired feed rates were obtained with no plugging of the feed tube. The system was found to be sensitive to variations in reactor pressure. Procedures were formulated to avoid such changes. Satisfactory feeder performance was achieved. Characterization of pretreated coal by solvent extraction was tested this quarter with excellent results. Thirteen coal batches were pretreated at various temperatures in steam and, for comparison, in helium. Twenty-seven extractions were carried out, including five of raw coal, using pyridine. To avoid thermal alteration of pretreated coal, extractions were carried out at room temperature. The results parallel our previous results on the pyrolysis of pretreated coal: pretreated coal gives about twice the extract yield of raw coal; extract yield is a maximum when pretreatment is at 340°C; pretreatment in helium does not improve extract yield; the effect of pretreatment on extract yield is destroyed if pretreated coal is exposed to air. These results support the theory that pretreatment partially depolymerises coal. Characterization of these extracts is expected to provide information on the chemistry of pretreatment. 12 figs., 2 tabs.

19900 **(DOE/MC/22049—2193) Fundamental mechanisms of coal gasification. Quarterly technical progress report.** Howard, J.B.; Ko, G.H.; Griffen, T.; Peters, W.A. (Massachusetts Inst. of Tech., Cambridge (USA)). 1986. Contract AC21-85MC22049. 24p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87000963.

Accomplishments for task 3 - integrated coal devolatilization model for reaction conditions pertinent to coal gasification are presented. A literature review of rapid pyrolysis models has been completed, and deficiencies in present models have been identified. A model applicable to all coal types and with potential for use over a wide range of operating conditions has been developed. The underlying rationale and working equations are presented. 22 refs., 2 figs., 5 tabs.

19901 **(DOE/MC/22146—2236) KILnGAS RAM I [Reliability, Availability, and Maintainability] test report.** (Allis-Chalmers Coal Gas Corp., Milwaukee, WI (USA)). Oct 1986. Contract FC21-85MC22146. 61p. NTIS MF A01; 2; GPO Dep. File Number DE87001042.

This report presents a summary of findings and results of the first phase of the KILnGAS Reliability, Availability, and Maintainability (RAM) test program. The first phase, known as RAM I, was completed in April 1986. The second step, RAM IIA, is scheduled for completion by the end of 1986; and the third step, RAM IIB, is planned to be completed by the third quarter of 1987. The RAM test program is being conducted by Allis-Chalmers Coal Gas Corporation using the KILnGAS Commercial Module (KCM). The KCM is a 600-ton-per-day coal gasification plant located in East Alton, Illinois, on the site of the Illinois Power Company's Wood River Generating Station. The KCM is designed to provide approximately 400 million Btu per hour of clean low-Btu gaseous fuel to a corner-fired 50 megawatt steam boiler. Design and construction of the plant was started in 1980. Commissioning and startup tests were initiated in mid-1983, and performance tests, which verified the technical feasibility of the KILnGAS process, using Illinois No. 6 coal, were concluded in December 1984. The RAM I program began on January 1, 1985. The overall goal of the RAM I program was to improve plant performance beyond that experienced during the 1984 demonstration run. This included modifications of the plant, principally to the ash discharge system, to permit operation at increased carbon conversion levels. Subsequent test results were generally positive. 19 figs., 6 tabs.

19902 (DOE/METC—87/6073, pp 239-250) **Potential role of hydrogen from low-Btu gas in heavy oil and tar sands extraction technology.** Magnie, R.L. Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

A combination of a coal source and a heavy oil/tar sand reservoir (both in marginal to uneconomic status) could provide the foundation for a new, economic, synergistic system in which the coal is utilized, additional heavy oil or bitumen is recovered, and a valuable hydrogen by-product is accumulated. In the proposed system, coal is converted to a low-Btu gas (150 Btu/cubic foot) containing for example 17% hydrogen, 15% carbon monoxide, 12% carbon dioxide, 51% nitrogen and 5% miscellaneous gases, and the low-Btu gas is injected into a heavy oil/tar sand reservoir at a down-dip location. The principal effects of the heavy carbon dioxide are in reducing viscosity and swelling of the heavy oil or bitumen, near the point of injection. The carbon monoxide and nitrogen will aid only slightly in viscosity reduction but will provide low solubility gas to aid in displacement of oil. The lightest-of-all, low solubility hydrogen will diffuse rapidly through the reservoir pore space and form a hydrogen-rich gas cap. 37 references, 3 figures, 7 tables.

19903 **(DOE/PC/60807—T11) Supercritical fluid chromatography/supersonic jet spectroscopy: Final report, August 1, 1983-August 31, 1986.** Lee, M.L. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemistry). Dec 1986. Contract FG22-83PC60807. 91p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87004004.

Capillary supercritical fluid chromatography (SFC) can be used to migrate and elute high-molecular-weight compounds that are present in coal-derived products, but the complexities of these mixtures surpass the resolving capabilities of this high resolution technique. In this study, the problem of sample complexity was addressed in two ways: (a) supercritical fluid sample prefractionation, and (b) capillary SFC with selective detection. For prefractionation, a supercritical fluid extraction/fractionation system was constructed and evaluated. A number of complex coal- and petroleum-derived materials were fractionated according to the number of aromatic rings using columns packed with an $NH_2$-modified stationary phase bonded on silica particles, and the group type separation of aliphatics, olefins, and aromatics was accomplished with a combination of silica and silver nitrate-modified columns.

19904 **(DOE/PC/70030—T5) Novel Fischer-Tropsch slurry catalysts and process concepts for selective transportation fuel production: Quarterly technical progress report, 1 January-31 March 1986.** Carroll, W.E.; Eliezer, K.F.; Withers, H.P. Jr. (Air Products and Chemicals, Inc., Allentown, PA (USA)). Jan 1987. Contract AC22-84PC70030. 231p. (CDS—200-94-Rev.2). NTIS MF A01; 2; GPO Dep. File Number DE87005648.

In the sixth quarter work continued on the three major tasks: Task 2 - Development of Improved Supported Catalyst Compositions; Task 3 - Slurry Reactor Kinetic Studies; and Task 4 - Fuel Product Characterization. To study the effect of Co-to-promoter ratio on the performance of the silica-supported catalysts, four Co/Zr/silica catalysts were prepared by varying the Zr loading, with the Co loading held at 4%. Gas phase testing of this series of catalysts was completed this quarter. It appears that the optimum Co/Zr ratio is near 0.5 for gas phase performance, although lower ratios were not investigated. The $Fe_3(CO)_{12}/Zr(OPr)_4$/silica cata-

lyst was gas phase tested to determine the inherent water-gas shift activity. This catalyst showed very little Fischer-Tropsch activity over the entire 220°C to 280°C temperature range. Slurry screening tests were performed on two catalysts. One was a Zr-promoted ruthenium catalyst supported on silica and the other was on a Zr-promoted, cobalt catalyst supported on silica. The extended slurry test which was begun last quarter continued this quarter. The same load of catalyst was run at 240°C for 1000 hours and then at 260°C for an additional 1200 hours. At each temperature, the catalyst underwent a gradual decline in activity. All liquid organic and wax products were collected during the initial 1000 hours of operation of the $Co_2(CO)_8/Zr(OPr)_4/SiO_2$ catalyst in the extended slurry test No. 8862-1-31, in order to isolate and characterize the diesel fuel fraction. The diesel fuel produced during this period of operation had a fairly high flash point, essentially no water or sediment, low sulfur, and negligible ash and carbon residue. It showed very low corrosiveness and had an outstanding cetane index. As a result it met all specifications for the highest quality diesel fuel oil except for very small variations from viscosity, cloud point and 90% boiling point. 5 refs., 53 figs., 98 tabs.

19905 **(DOE/PC/90911—4) Reactivity of heteroatom-containing organics during liquefaction of subbituminous coal: Quarterly technical progress report, December 15, 1986-March 15, 1987.** Knudson, C.; Hawthorne, S. (North Dakota Univ., Grand Forks (USA). Energy Research Center). 1987. Contract FG22-86PC90911. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006450.

Based on thermogravimetric analysis (TGA) of Wyodak subbituminous coal, four pyrolysis temperatures were selected (160, 250, 300, and 350°C) and pyrolysis-GC/MS analysis was performed on individual coal samples at each temperature. Eighteen deuterated standard compounds and two deuterated hydrogen donor compounds have been synthesized and, in most cases, both isotopic and chemical purity of the products was >90%. A 1.0 liter Hastelloy autoclave was used to synthesize 30 grams of deuterated anthracene oil solvent (AO4). Good isotopic purity was obtained with no detectable degradation of the AO4 component species. Solid state $^{13}C$ NMR spectra of coal and coal char were obtained which verifies the rejection of hydrogen rich organics at low temperatures. An alumina dilution technique was used to obtain the spectra. This preliminary data indicates that the rejection of material during the charring of Wyodak coal at 350°C resulted in the aromatization of 9 to 36% of originally aliphatic carbon atoms. 12 figs., 2 tabs.

19906 **(DOE/PC/90912—T2) Low severity coal liquefaction to determine reactivity of coals: Technical progress report No. 2 for period 09/01/86 through 11/30/86.** Chung, K.E. (Rockwell International Corp., Thousand Oaks, CA (USA). Science Center). Jan 1987. Contract FG22-86PC90912. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005901.

The objectives of this investigation are (1) to determine the reactivity of bituminous coals for liquefaction using moderate temperature hydrogenation, and (2) to examine the reaction chemistry involved in the moderate temperature liquefaction as a function of reaction time, temperature and catalyst application. The experimental work involves hydrogenation of a bituminous coal at 325°C in the absence of a donor solvent and catalyst. Then, the effect of reaction temperature and catalysts will be studied at temperatures between 300 and 350°C using two catalysts, $FeS_2$ and ammonium molybdate. Three reactions of an Illinois bituminous coal were carried out at 325°C under $H_2$ pressure of 2900 psig for 3, 14 and 27 h. Conversion to gaseous and soluble products was close to 90% in 14 and 27 h reactions. Preliminary data from the 3 h reaction showed substantially lower conversion. Yields of oil, asphaltenes and preasphaltenes were similar in the 14 and 27 h reactions: the yield ratio was 2:3:1. Elemental composition revealed that oils and asphaltenes of 14 and 27 h reactions are similar, respectively, while preasphaltenes are significantly different. Atomic H/C ratio of the products ranged from 0.95 to 1.24, indicating substantial hydrogenation and/or deoxygenation. The similar product distribution and composition indicate that the formation of oil, asphaltenes and preasphaltenes was essentially completed within 14 h of reaction time. Oil, asphaltenes and preasphaltenes are significantly different from each other in H/C ratio and oxygen content. Considering little change in the product distribution after 14 h, the differences among the fractions suggest that the fractions were derived from different precursors in the feed oil. 2 refs., 2 figs., 3 tabs.

19907 **(EPRI-AP—5047) Coal gasification tests at TVA [Tennessee Valley Authority]: Final report.** Crim, M.C.; Williamson, P.C. (Tennessee Valley Authority, Muscle Shoals, AL (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 136p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920264.

This report presents the results obtained from the EPRI co-funded tests conducted at TVA's 200 tpd Texaco coal gasification facility equipped with a water quench gasifier. Four US coals were tested at TVA: (1) Utah coal from the SUFCO mine, (2) Illinois No. 6 coal from the Amax Delta mine, (3) Pittsburgh No. 8 coal from the Blacksville No. 2 mine and (4) a high ash-fusion Maryland coal. The TVA tests were of short term duration totaling approximately 10 to 20 days of cumulative operation on each coal. The gasification behavior of each coal was tested under a wide range of process conditions and feed characteristics. All four coals produced carbon conversion of 92% or higher. Utah and Illinois No. 6 coals achieved carbon conversions of 95 to 97%. The high heating value Pittsburgh No. 8 coal had lower carbon conversion because the maximum allowable gasifier temperature was reached at relatively low O/C ratios. The high-ash fusion Maryland coal was gasified with a fluxing agent at temperatures within the design limit of the TVA gasifier. The gasification behavior of the coals was similar to that observed from tests at other Texaco gasifiers. However, earlier experiments at Texaco's Montebello Research Laboratories showed higher values for both carbon conversion and coal gas efficiency. 27 figs., 35 tabs.

19908 **(EPRI-AP—5049) Liquid-entrained catalyst operations at LaPorte Pilot Plant for liquid-phase methanol process, 1984-1985: Final report.** (Air Products and Chemicals, Inc., Allentown, PA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. Contract AC22-81PC30019. 286p. NTIS, PC A13/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303; 1; GPO Dep. File Number DE87006950.

Liquid-entrained operations at the LaPorte LPMEOH Process Development Unit (PDU) were performed under Task 10 of Contract No. AC22-81PC30019 for the US Department of Energy. During June 1984, a 6-day, high-slurry concentration run (45 wt %, Run E-2) demonstrated the ability of the PDU to operate smoothly with a high solids loading. The catalyst activity observed during Run E-2 did not compare well with the bench-scale predictions. This was in part due to an inadequate reduction. Mass transfer limitations may have also contributed to reduced catalyst performance, but this effect was masked by the inadequate reduction of the catalyst. Data from a previous activity maintenance run (Run E-1) indicated that metal carbonyl catalyst poisons were limiting catalyst performance. In order to determine catalyst activity maintenance characteristics in a poison-free system, specific materials of construction were upgraded based upon their potential for metal carbonyl formation. This work culminated in a successful 40-day run (25 wt %, Run E-3) during May-June 1985. A successful in-situ reduction was accomplished, and catalyst deactivation rates were comparable to the best laboratory performance under CO-rich synthesis gas ($H_2/CO = 0.69$). The average decline in methanol productivity was 0.28%/day, and a nominal 4,540 kg/day (5.0 ton/day) crude methanol was produced. 5 refs., 23 figs., 36 tabs.

19909 **(EPRI-AP—5050) LaPorte liquid-phase methanol process development unit: Continued operation in liquid-entrained catalyst mode: Final report.** (Air Products and Chemicals, Inc., Allentown, PA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. Contract AC22-85PC80007. 85p. NTIS, PC A05/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303; 1; GPO Dep. File Number DE87006897.

The LaPorte LPMEOH Process Development Unit (PDU) was operated in July 1985 under Contract No. DE-AC22-85PC80007. This test (Run E-4) utilized catalyst powder F21/OE75-35 at an initial 41 wt % (oxide basis) solids concentration. This slurry was successfully activated using an improved in-situ re-

duction technique. Both CO-rich ($H_2/CO$ = 0.69) and balanced ($H_2/CO$ = 2.89) reactor feed gas were tested at 250°C (482°F) and 5270 kPa (765 psia). Superficial gas and liquid velocities were varied from 12.2 to 15.6 cm/s (0.40 to 0.51 ft/s) and 1.8 to 6.5 cm/s (0.06 to 0.21 ft/s), respectively. Slurry concentration was also changed from 47.4 wt % to 33 wt %. The PDU achieved a 100% on-stream factor and was shut down after 231 hours of operation. Methanol productivity for all cases was less than the laboratory prediction. A mass transfer limitation and/or inadequate gas/slurry mixing are believed to exist in the present LPMEOH reactor system at elevated solids loadings (above about 30 wt %). Future work to identify other liquid media and reactor internals is planned within other tasks of this program. 2 refs., 7 figs., 9 tabs.

19910 **Coal liquefaction and hydrogen utilization at low temperatures.** Bockrath, B.C.; Illig, E.G.; Finseth, D.H.; Sprecher, R.F. (Dept. of Energy, Pittsburgh, PA). *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry;* **29**: No. 5, 76-82(1984).

The initial conversion of coal to material that may be extracted by polar solvents such as tetrahydrofuran or pyridine requires only relatively mild liquefaction conditions. The chemistry of the initial dissolution steps is very likely to be of great importance to the overall liquefaction process in that the yield and character of the initially formed products may greatly influence the success of subsequent liquefaction steps. Although conversion to the initial products seems to require a minimum of bond breaking, hydrogen-deuterium exchange reactions indicate that a rich chemistry transpires at the same time. In the following experiments, the conversion of coal was examined as a function of several variables over the range of temperatures from 300 C to 450 C. The net change in both the content and the distribution of hydrogen among the products was followed using an analytical scheme based on elemental and NMR analyses. This method has been used to determine the net hydrogen utilization divided among categories for hydrogenation, hydrocarbon gas formation, heteroatom removal, and matrix bond breaking. 9 references, 4 figures, 2 tables.

## 0106 Properties

*REFER ALSO TO CITATION(S) 19892, 19897, 19904, 19935, 19962, 19987, 19989, 20317*

19911 **(CONF-860548—5) Modelling the rheological behavior of high solids CWM systems using a new rheological equation.** Hafaiedh, A.; Dinger, D.R.; Funk, J.E. (New York State Coll. of Ceramics, Alfred (USA)). May 1986. Contract FG22-84PC70804. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006443.

From 8. international symposium on coal slurry fuels preparation and utilization; Orlando, FL, USA (27 May 1986).

The understanding of the rheology of concentrated suspensions is an important part of the control and preparation of ceramic slips and pastes and coal water slurries. Many studies have been conducted on concentrated suspensions; many attempts have been made to formulate equations which describe their behavior; and many attempts have been made to use these equations to predict the behavior of slurries and slips. This paper describes a modification to one of the more commonly used rheological equations, the Bingham equation [E.C. Bingham, "An Investigation of the Laws of Plastic Flow", Bulletin of the Bureau of Standards", Volume 13, pp. 309-353 (1916-1917)], and the initial attempts to use it to understand and model the rheological behavior of high solids CWM. The paper will include the description of the new equation, its derivation, and examples of the various forms of the resulting rheograms. Then in the second part of the paper, the equation will be used to analyze the behavior of some typical CWM systems made from Cedar Grove and Moss seam coals. 8 refs., 18 figs.

19912 **(CONF-8510411—1) Computer-assisted qualitative and quantitative analyses of energy-related complex mixtures.** Stamoudis, V.C.; Picel, K.C. (Argonne National Lab., IL (USA)). 24 Oct 1985. Contract W-31109-ENG-38. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004960.

From Environmental Protection Agency symposium on short-term bioassays in the analysis of complex environmental mixtures; Research Triangle Park, NC, USA (20 Oct 1985).

Recent advances in the efficiency of gas chromatography (GC) columns and improvements in instrument hardware and computer software have facilitated rapid and accurate analysis of complex organic mixtures. By applying manufacturer-supplied software (calibrated-peak methods) and custom software based on retention indices (RI) (Demirgian, 1984; Stamoudis and Demirgian, 1985), most of the classes of chemicals in these mixtures can be rapidly analyzed both qualitatively and quantitatively. Sample prefractionation is essential because it produces simpler mixtures for GC analysis, and it separates constituents by chemical class, which aids automated identification. In the analysis of any new material, existing sample preparation procedures are validated for the material or modified to produce well-resolved chemical class fractions. Representative samples and their subfractions are characterized by GC/mass spectrometry (GC/MS) before analysis by computer-assisted GC. During our studies of the toxicological interactions of chemicals in complex mixtures, we have isolated, subfractionated, and characterized the neutral components of a variety of energy-related materials. Here we present chemical characterization and mutagenicity data of selected fractions from three coal-gasification by-product tars, two from pilot-plant gasifiers, and one from a commercial scale gasifier, and analogous data for aromatic subfractions from two additional pilot gasifiers, as well as one from the commercial gasifier. 22 refs., 3 figs., 2 tabs.

19913 (DOE/PC/70771—T4, pp 2.1-2.8) **Heterogeneous NO reduction: Single-pulse shock tube studies of global rates and mechanisms of NO and HCN reactions on flame-borne particulates.** Lester, T.W.; Babcock, L.; Cheng, M.T. (Louisiana State Univ., Baton Rouge). [1987]. NTIS, PC A04/MF A01. File Number DE87005647. Contract AC22-84PC70771.

In Kinetics of nitrogen and sulfur reactions in combustion systems: Quarterly report No. 6.

The NO/carbon black reaction has been investigated in a 5.08 cm dia single-pulse shock tube. Using the gas chromatographic technique developed previously for NO measurements, a series of measurements of NO reduction with and without carbon black particles behind reflected shock waves were conducted. The experiments covered the temperature range between 1200 to 2000 K. The pressure and dwell time were kept approximately at 2 atm and 1 ms, respectively. The powder dispersion technique was changed during this period. Instead of dispersing the powder by shock flow, an aspirator was used to disperse the powder into the shock tube prior to the shock. The advantage of this approach is to ensure that all NO is exposed to the particles. A new aspirator was designed, fabricated and tested with carbon black powder. The sampling system was modified in order to inject the particles and sample the gas products from the end plate. Two gas chromatographs were used to detect NO, $N_2$, CO, $CO_2$ and hydrocarbons. The experimental results show that the reduction of NO for the NO/carbon black reaction is consistently higher than for homogeneous processes alone. The reaction rate obtained from these data was about one order of magnitude higher than the reaction rate constant for the NO/char reaction. The data analysis has included the derivation of the temperature of the suspended particles behind reflected shock. Particle temperatures can be up to a few hundred degrees (d) lower than the shock heated gas for a 20 mg particle loading. 2 refs.

19914 **(DOE/PC/70796—11) Characterization of a resinite maceral fraction.** Bodily, D.M.; Kopp, V. (Utah Univ., Salt Lake City (USA). Dept. of Fuels Engineering). 1987. Contract FG22-84PC70796. 5p. (CONF-870410—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002299.

From 193. national meeting of the American Chemical Society; Denver, CO, USA (5 Apr 1987).

In a study of the swelling of coal macerals in organic solvents, a resinite maceral fraction was separated from Hiawatha, Utah coal. Hiawatha coal is from the Wasatch Plateau field, and dates from the Cretaceous period. Coals of the Wasatch Plateau are relatively rich in resinite. As part of the study of maceral swelling, the properties of the resinite fraction were measured. Relatively pure resinite fractions were recovered from coal using the density

gradient centrifugation technique. The resinite separated from Hiawatha, Utah coal is highly aliphatic. The chemical structure of this resinite appears to be different from those of amber and resinites from bituminous coals and lignites separated and studied by Murchison [Murchison, D.G., "Properties of Coal Macerals. Infrared Spectra of Resinites and Their Carbonized and Oxidized Products", Coal Science, Given, P.H. Ed., Advances in Chemistry Series, 55, Am. Chem. Soc., Washington, 1966, chap. 19.], although some of the differences may be attributed to purity of the samples. The unique properties of the resinite account for its use as a chemical. 7 refs., 2 figs., 1 tab.

19915 **(DOE/PC/80911—T5) Linkages and aromatic clusters in a bituminous coal: Quarterly technical progress report No. 5 for the period 09/01/86 through 11/30/86.** Chung, K.E. (Rockwell International Corp., Thousand Oaks, CA (USA). Science Center). 1986. Contract FG22-85PC80911. 6p. (SC—5438-QPR). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006409.

An Illinois No. 6 coal was solubilized in reactions with NaOH/ethanol/$H_2O$ at 260, 300 and 320C, which are called Ill-260, Ill-300 and Ill-320, respectively. Major results previously presented include 94% conversion to soluble and gaseous products with 80% yield of soluble products, 0.2% ash content in the soluble product, 114% hydrogen recovery and an increase of the H/C ratio of the product to 1.07 from 0.80 of the coal, hydrogen addition to the feed occurred by hydrolysis of oxygen functional groups, effective separation of the soluble product into fractions of different aromatic cluster size, and molecular description of each fraction using average structural parameters. In addition, a molecular structural model of the Illinois coal was constructed, and product distribution and a minimum hydrogen requirement in the hydroliquefaction of the coal were predicted. Average molecular structural parameters revealed that molecular size and carbon aromaticity of Ill-320 product fractions decreased significantly, compared with those of Ill-300 fractions, but the aromatic cluster size increased. These changes indicate that additional cleavage of linkages took place at 320C, but some fusion of the aromatic clusters occurred. Combining with previous data on element balances and $CO_2$ yield, the structural data suggest that phenol rings in aromatic clusters were opened. This observation suggests that the linkages of the coal are reactive at substantially lower temperatures than the hydroliquefaction temperatures, 370 to 430c, but the cleavage of the linkages can lead to aromatization under certain conditions. 2 figs., 2 tabs.

19916 **(DOE/PC/90527—T1) Characterization of oxidized coal surfaces: Quarterly report, September 1986-December 1986.** Hercules, D.M. (Pittsburgh Univ., PA (USA). Dept. of Chemistry). 1986. Contract FG22-86PC90527. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005501.

The work performed during this reporting period has focused primarily on defining derivatization reactions for initial investigation. The necessary reagents (Girard's Reagent P and $NaHSO_3$) and high purity charcoal were procured and the laser mass spectra (LMS) obtained. The LMS of the charcoal was obtained using a wide range of laser energy and focusing conditions. The information obtained will be applied in future work once the derivatization of model compounds on Zn foils and on charcoal commences. Paralleling the developments mentioned above were efforts in establishing a collaboration between Conoco (Pittsburgh, PA) and our research group. The collaboration is expected to result in a mutually beneficial exchange of information regarding coal oxidation studies. 4 figs.

## 0108 Waste Management

*REFER ALSO TO CITATION(S) 19894, 19907, 19947, 21061, 21064*

19917 **(CONF-861132—2) Enhancing double-alkali and lime/limestone flue-gas-desulfurization chemistries to promote NO/sub x/ removal.** Harkness, J.B.L.; Doctor, R.D.; Livengood, C.D. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87004687.

From 10. symposium on flue gas desulfurization; Atlanta, GA, USA (18 Nov 1986).

Significant progress in the development of NO/sub x/-control additives for conventional wet-scrubber chemistries has recently been made at Argonne National Laboratory (ANL). Laboratory-scale research has resulted in additive formulations and preparation techniques that permit high levels of simultaneous NO/sub x/ and SO/sub x/ removal to be maintained for a significant period in chemistries and flue-gas environments typical of utility FGD systems. That work has resulted in the awarding of a US patent (1) and is the basis for the preliminary process concept described in this paper. The research was conducted as part of the "Development of Combined NO/sub x//SO/sub x/ Environmental Control Technology" program sponsored by the US Department of Energy through the Pittsburgh Energy Technology Center. This continuing program emphasizes the investigation and development of a variety of post-combustion control options and currently includes both laboratory- and industrial-scale research into NO/sub x/-control techniques applicable to spray-dryer systems.

19918 **(DOE/MC/21108—T2) Management of coal waste by energy recovery: mild gasification/flash pyrolysis of coal preparation wastes. Quarterly report, January-March 1986.** Chu, Charles I.C.; Gillespie, B.L. (UCC Research Corp., Bristol, VA (USA)). Jun 1986. Contract AC21-84MC21108. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012727.

Construction continued on the Mild Gasification Unit, MGU, with the addition of the vacuum pump. The MGU can now be operated under vacuum conditions. Modifications were made to the reactor tube packing box after leaks were discovered around the old packing boxes. The new packing box is taller and wider than the old packing box allowing more effective packing. Preliminary testing shows a good vacuum seal is obtained with the modified packing box. Eight tests were conducted on the MGU. Each of the eight tests were considered a shakedown test. A variety of reactor tube configurations, condensing systems, and operating conditions were tested. It was found that operating under vacuum conditions improved the quality of liquids. Also, it was found that coal residence times can be significantly reduced by operating at increased furnace temperatures. The MGU has performed well with no major problems. The only significant problem encountered to date has been effective condensation of the hydrocarbon gases. Continuing efforts are being made toward improving the condensation system on the MGU.

19919 **(DOE/PC/91022—1) Acoustic agglomeration of power plant fly ash: Semi-annual technical report, 5/6/86 to 11/5/86.** Reethof, G. (Pennsylvania State Univ., University Park (USA). Noise Control Lab.). 22 Dec 1986. Contract AC22-86PC91022. 50p. (CAES—789-87). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005609.

The objective of this project is to complete the investigations on the use of high intensity acoustic energy to agglomerate micron and submicron sized particulates in fly ash aerosols in order to provide the necessary scientific knowledge and design criteria for the specification of technically and economically viable intermediate flue gas treatment of coal fired power plants. The results of the project are to provide technical and economic information for the better development and evaluation of potential fine particulate control systems.

19920 **(PB—87-133419/XAB) Environmental aspects of fly-ash application in the Netherlands.** Bolt, N.; Snel, A. (Keuring van Electrotechnische Materialen N.V., Arnhem (Netherlands)). 1986. 21p. NTIS, PC PC E03/MF E01.

Published in Kema Scientific and Technical Reports v4, n11 p125-140 1986. See also PB86-123502.

The paper deals with the types of fly-ash application now in use in The Netherlands, with emphasis on the environmental effects and particularly those due to leaching. Possible applications for road construction are considered in detail. Simple and quick laboratory tests can be applied in many cases to assess, with regard to the environment, the properties of the fly ash and the products in which fly ash is incorporated. The relation between, on one hand, the standardized cascade test and a diffusion test that is being de-

veloped and the actual practice on the other hand is dealt with in order to assess the value of such tests. It appears that discrepancies exist between the values predicted with diffusion and cascade tests and the values measured under (semi)practice simulation conditions. Two parameters that influence the results are elaborated upon; the difference in the water evaporation/flow pattern and the difference in redox conditions. The overall results indicate that, in order to evaluate laboratory data properly, supplementary field measurements are indispensable for each new type of fly-ash application.

19921 **Technical status report: development of lime based in-duct scrubbing.** Shilling, N.Z.; Samuel, E.A.; Pennline, H. (Dept. of Energy, Pittsburgh PA). *Proceedings of the American Power Conference;* **48**: 365-372(1986). (CONF-860422—).

From American power conference; Chicago, IL, USA (14 Apr 1986).

Lime Based In-Duct Scrubbing (LIBIDS) was one of the candidate technologies receiving contract awards for pilot demonstration by the U.S. Department of Energy under the Acid Rain Precurser program. The concept as developed by General Electric utilizes rotary atomization of lime slurry directly within flue gas carrying ductwork to remove $SO_2$. This promises to be a very low capital cost method of $SO_2$ control with capital plus levelized operating cost estimated to be 364/KW. Several significant technical milestones have been passed relative to proof of principle and ultimate commercialization. Based on positive results from laboratory and supporting analytical work, a detailed engineering design has begun for a pilot plant, to be installed on the American Electric Power System, which will operate in a slipstream from the Unit 5 boiler at Ohio Power Company's Muskingum River Plant. Confirmation of pilot scale and recommendations for flow control configurations have been obtained from cold flow clearwater atomization model tests at the scale of the slipstream pilot. The radial penetration of the droplet plume from the atomizer was scaled from simulated to actual pilot conditions through a detailed finite element solution. The results show that nearly complete (2% free residual moisture) drying is obtained at one-second of residence time. Since the net effect of solids is to increase drying rates, handleable material may be achieved within 0.5 second. This hypothesis will be specifically tested in the pilot stage. Finally, pilot arrangement and test plan have been finalized and are described herein. 3 references.

19922 **Performance and economics of a spray-dryer FGD system used with high-sulfur coal.** Livengood, C.D.; Farber, P.S. (Argonne National Lab., IL). *Proceedings of the American Power Conference;* **48**: 840-846(1986). (CONF-860422—).

From American power conference; Chicago, IL, USA (14 Apr 1986).

Flue-gas desulfurization (FGD) systems based on spray drying appear to offer advantages over wet lime/limestone systems in a number of areas: low energy consumption, low capital cost, high reliability, and production of a dry waste that is easily handled and disposed of. Uncertainties regarding the performance and economics of such systems for control of high-sulfur-coal emissions have slowed adoption of the technology in the Midwest and East. At Argonne National Laboratory, we have had more than four years of operating experience with an industrial-scale dry scrubber used with a boiler firing high-sulfur (3.5%) midwestern coal. This paper summarizes our operating and research experience with that system and describes the current research program, which includes an in depth characterization of the system. 3 references.

## 0109 Environmental Aspects

*REFER ALSO TO CITATION(S) 21126*

19923 (DOE/ER/60152—1-Pt.2, pp 752-760) **Blackhawk/Star Point Sandstone aquifer system hydrogeology northern Wasatch Plateau, central Utah.** Grace, S.R. (Nuclear Regulatory Commission, Washington, DC). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The Blackhawk/Star Point aquifer system of the northern Wasatch Plateau Coal Field is an aquifer system of low primary permeability occurring in the Upper Cretaceous strata in central Utah. An improved understanding of this aquifer system is important to the Utah coal mining industry, as the major coal seams mined in central Utah are directly associated with these strata. A better understanding of the hydrogeology is needed to more accurately predict the probable hydrologic consequences of mining to satisfy the regulatory requirements of Public Law 95-87. The Blackhawk/Star Point aquifer system can be divided into two hydrostratigraphic units: the upper Blackhawk Formation and the lower Blackhawk and Star Point Sandstone Formations. This unit exhibits relatively poor hydrologic characteristics except where faulted due to the properties of the shales. The lower Blackhawk/Star Point hydrostratigraphic unit contains numerous fluvial channel sandstones but is best represented by three massive, areally extensive, sandstone units (tongues) interbedded with shales and siltstones of low permeability. These sandstone tongues are separated by low permeable shales and are generally not interconnected hydrologically except where faulting, fracturing or jointing has resulted in increased secondary permeability. 28 references, 4 figures.

19924 **(ECN—85-40) Measurement of the background concentration in precipitation.** Slanina, J. (Netherlands Energy Research Foundation, Petten). Nov 1985. 69p. (In Dutch). ECN, P.O. Box 1, 1755 ZG Petten, The Netherlands.

The project is part of the National Coal Research Program and investigates the air pollution caused by coal-fired installations. The aim was to measure the concentrations and depositions of bulk and trace elements at a location. Initial experiments at ECN indicated that the existing values for the wet deposition of trace elements were not reliable and tended to overestimate the concentrations of trace elements in precipitation.

19925 **(PB—87-129862/XAB) Economic-impact analysis of R84-29 mine-related water-pollution regulations.** Huff, L. (Huff and Huff, Inc., La Grange, IL (USA)). Sep 1986. 151p. NTIS, PC A08/MF A01.

The report discusses the economic impacts of both the IEPA proposed rule change and the Illinois Coal Association's proposed rule change concerning discharges from mine-sedimentation ponds. Present Illinois effluent regulations specify certain effluent limits for dry-weather mining discharges. During wet-weather events, the effluent concentrations are not applicable if the sedimentation pond is designed to contain runoff from all storms smaller than a 10-year, 24-hour occurrence. These existing regulations are no longer consistent with federal coal mining guidelines. In line with the USEPA changes, the Illinois Coal Association (ICA) has introduced a regulatory proposal that deletes the optional design criteria and replaces it with a performance standard based upon attaining a settable solids of 0.55ml during wet weather. The IEPA has introduced a counter proposal which, in essence, retains the design criteria but eliminates the requirement for wet-weather monitoring.

19926 **Energy scenarios in addressing the $CO_2$ question.** Rotty, R.M.; Reister, D.B. (Oak Ridge Associated Universities, TN). *Journal of the Air Pollution Control Association;* **36**: No. 10, 1111-1115(Oct 1986).

A reference scenario for $CO_2$ emissions was developed using a model of world energy supply and demand. In the reference scenario, world GNP and world energy demand increase at average rates of 2.1 percent per year and 1.5 percent per year respectively during the period 1975-2100. The corresponding annual $CO_2$ emissions rise to a maximum of 16 gigatons of carbon around 2050 and then decline as a result of a transition to nonfossil fuel energy systems. A modified scenario for high $CO_2$ emissions was obtained by assuming an abundant supply of low cost coal, thus eliminating the transition. A low case was developed in which the low cost of alternative energy (i.e., solar, nuclear) induces an earlier shift away from fossil fuels. Annual emissions of the three scenarios were used as input to a global carbon cycle model and the $CO_2$ buildup in the atmosphere during the period 1980-2100 was determined by the model. All three scenarios showed continuous rise in atmospheric $CO_2$ concentration. The reference scenario reached 775 ppm by 2100. The high $CO_2$ case resulted in concentrations of over 1040 ppm, and for the low case the 2100 concentration was just under

700 ppm. If the climate theory is correct, even 700 ppm is sufficient to give significant climate warming, but by experiencing the change gradually over a century, adaptation may not be painful. An early transition to nonfossil fuel supplies makes the problem less severe but does not eliminate it. 5 references.

## 0110 Reserves And Exploration

*REFER ALSO TO CITATION(S) 19940*

19927 **(LA-UR—86-4382) Peat deposits in Panama: Their potential for use in energy applications.** Ramirez, A.; Thayer, G.; Cohen, A.D.; Allen, A. (Los Alamos National Lab., NM (USA); Instituto de Recursos Hidraulicos y Electrificacion, Panama City (Panama); Allen (Andrew), Plymouth, NC (USA)). Dec 1986. Contract W-7405-ENG-36. 15p. (CONF-870246—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003762.

From International Peat Society symposium on tropical peat and peatlands for development; Yoguakurta, Indonesia (9 Feb 1987).

A major peak bog has been discovered in the Changuinola area of Panama. The bog averages 8-m deep, is thought to be 82 $km^2$, in area and the peat has an ash content of about 4%. It is estimated that this size peat bog could support a 30-MW power plant for 360 years. Preliminary cost estimates for using the peat in an electrical power plant give an estimated cost of electricity of 0.09$US/kWh if wet mining is used and 0.079$US/kWh if milled peat is used. 2 refs., 4 figs.

## 0120 Mining

*REFER ALSO TO CITATION(S) 19894, 19895*

19928 **(ECE—COAL/GE.4/R.20) Improvement of reliability of opencast mining techniques in difficult geological, mining and climatic conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 11 Mar 1986. 13p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This consolidated report sums up and synthesises information received from individual Governments and the results of scientific research and practical experience in Czechoslovakia. The report stresses certain aspects which should be taken into account when considering specific factors and their effects on essential forms of activity at an opencast mine and suggests some processes which may ensure the necessary reliability and steadiness of operation and, consequently, the desired degree of efficiency. Topics covered are geotechnical factors, mining technology factors, climatic factors, factors relating to the mining technique used, factors relating to the mining and transport equipment used, combined effects of various factors, time element in the determination of factors affecting the reliability of the mining complex and operational measures.

19929 **(ECE—COAL/GE.4/R.29) Activities of the National Mining Research Institutes of ECE countries and exchange of scientific, technical and economic information relating to the coal industry.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 19 Nov 1985. 6p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper presents project work within each of the five technical divisions currently responsible for research and development at the National Coal Board's Research and Development Establishment (MRDE); these divisions are Mining Sciences, Coal Preparation, Automation and Mechanisation, Management Systems and Reliability. The aims of the research and development programme are to formulate and apply new technologies to the mining and preparation of coal, enabling mine management to achieve growth in performance, saleable products and revenues, and the labour force to work effectively and safely. Topics covered by the paper are general policy and technical policy of MRDE, program strategy in the mining sciences division, coal preparation division, automation and mechanisation division, management systems division and reliability division; technology transfer and university and R & D work.

19930 **(ECE—COAL/GE.4/R.30) Authority and responsibility of advisory bodies and project assessment procedures to support decisions on research and development priorities and programmes.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 26 Feb 1986. 9p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This consolidated report gives an account of the similarities and differences among the countries providing national reports and a general idea of procedures for establishing research and development programs to meet the needs of the mining industry. Topics covered are: decision-making bodies and ways in which they direct research; organization of the research assessment system; research work planning procedures and principles for financing research and development work. The paper concludes that the harmonious economic development of the country and coal industry requires research and development activity to promote intensive technical progress, research and development activity is stimulated by decision-making bodies, subsidiary bodies for stimulating the research process are the advisory bodies which prepare for decision-making bodies' opinions and that methods and procedures for evaluating the research process are fairly formal and their aim is to ensure maximum effectiveness of research findings.

19931 **(NP—7770074) Transport of resins in coal mining. Technical and economic comparison between conventional and HF canister or tank transport techniques.** Graf, S. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen). 31 Jul 1985. 119p. (In German). NTIS (US Sales Only), PC A06/MF A01. File Number DE87770074.

The transport of resins, in particular isofoam and polyurethane components, was investigated in a Ruhr mine. The efficiency and economics of the different transport systems were compared. Procedures and rationalisation measures were discussed. The total cost, i.e. capital cost and operating cost, was analyzed, and cost reduction measures were pointed out. The author referred to a cost-benefit analysis of transport systems and processes. (HLN).

19932 **(ECE—COAL/GE.4/R.311/Add.6) Drivage, development and support of roadways and faces in deep mines and, consequently, in more difficult mining, geological and atmospheric conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 26 Feb 1986. 9p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

The hardcoal deposits in the coalfields of the Federal Republic of Germany reach down to 1500 m depth. As mining activities move down to this depth and the difficulties in roadheading and strata control increase the following parameters have to be considered: Mine climate; rock pressure; rock burst hazards; gas emissions and hazards of spontaneous combustion. Topics covered in the paper are deposits, roadway drivage, roadheading by shot-firing, mechanized stone drifting, mechanized in-seam drivages, strata control including roadway support systems and face support systems. The paper concludes that the problems can be overcome by improved technology and appropriate layout of workings and gives suggestions of measures that could be undertaken.

19933 **(ECE—COAL/GE.4/R.20/Add.13) Improvement of reliability of opencast mining techniques in difficult geological, mining and climatic conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 20 Feb 1986. 6p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

The intensification of opencast coal mining in the USSR has been connected with the introduction of technological systems involving excavator loading of the spoil at opencast mines in the Soviet Far East, Eastern Siberia, the Kuzbass and other areas with difficult natural and climatic conditions. This paper discusses means of improving reliability of opencast mining and gives suggestions. Topics covered include methods of increasing the size of internal dumps while maintaining stability where internal dumps are often on worked out opencast sites. The principle method used to increase stability is that of preparing the base of the dump by providing special preventative excavations. Improvements in the non-transport system of internal dumping have been made although methods using conveyor spoil stackers involve the drainage of the deposit. Improved reliability of opencast mining also involves the efficiency of blasting operations. One method discussed in the paper is the use of multipoint initiation of explosive charges to reduce misfires of borehole charges and a numerical probability assessment is described. The improvement in reliability of means of transport at opencast mines is also described mainly due to technological advances.

19934 **(ECE—COAL/GE.4/R.29/Add.7) Consideration of scientific and technical activities of mining research and design institutes in the period 1983-85.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 20 Feb 1986. 6p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

In order to develop the economy of the Soviet Union a substantial increase in coal production is required. This means that the re-equipment of mines on the basis of highly efficient technological processes and high output automated mining machinery is necessary. The implementation of this program confronts the industry's research and design organisations with problems. The fundamental research by the national mining research institutes is aimed at speeding up the industry's technological progress, improving labour productivity and safety and reducing production costs. Special attention is being given to perfecting coal-getting operations in thin and deep seams, developing machinery systems for unmanned coal-winning and improving working conditions and safety. Research areas outlined in the paper are heading machines, mechanization of winning operations. T-junction supports, prevention of caving by chemical reinforcement of rock, opencast technology, drilling and blasting and environmental effects.

19935 **(ECE—COAL/GE.4/R.29/Add.6) Activities of the National Mining Research Institute of ECE countries and exchange of scientific, technical and economic information relating to the coal industry.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 10 Feb 1986. 12p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper describes the research and development activities of the coal industry of the Federal Republic of Germany. Topics covered are as follows: objectives of research and development activities in the coal industry; institutes in charge of research and development work within the coal industry, including those in the hard-coal industry and those in lignite mining; main fields of research and development in the hard coal industry including mining technology and safety, mine surveying and prevention of rock bursts; dust suppression and pneumoconiosis prevention, mine ventilation and climitization, mine rescuing, flameproofing and explosion protection, ergonomics, data-processing and mine organisation, testing of materials, roadheading technology, mine support systems and rock mechanics, mining methods and infrastructure, mining and face conveying technology and remote control technology; main fields of R & D in coal refinement and utilization including coal preparation, technical servies for cokefaction, experimental coking plants, process technology, analytics, coal chemistry and heat and power generation; co-operation with similar institutes abroad.

19936 **(ECE—COAL/GE.4/R.29/Add.5) Activities of the National Mining Research Institutes of ECE countries and exchange of scientific, technical and economic information relating to the coal industry. Scientific technical and economic characteristics of Hungarian coal mining.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 30 Jan 1986. 3p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

Hungarian coal deposits are highly varying in their quality and dimensions as well as geological age and Hungarian coalfields are categorised into four main groups. This paper outlines the main features of coal production and uses in Hungary. It describes the focussing of scientific research associated with the exploitation of mineral reserves deposited in difficult geological conditions. Main research topics cover those associated with the complete utilization of mineral resources, work safety and environmental protection.

19937 **(ECE—COAL/GE.4/R.31/Add.5) Drivage, development and support of roadways and faces in deep mines and, consequently, in more difficult mining, geological and atmospheric conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 30 Jan 1986. 2p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper considers the research into drifting and cutting technologies and the development of drift and face supporting techniques by the Central Institute for the Development of Mining in Budapest. The results of this research have been practically used in and adapted to nearly the whole area of the Hungarian mining industry. In the case of the research into drifting work the aim was to find an optimal supporting method, and the interrelationships between support and strata were studied by in-situ strain measurements. In the development of cutting technologies, the optimal density and resistance of support, necessary on faces supported by shields, were determined by making rock pressure and convergence measurements on a number of faces.

19938 **(ECE—COAL/GE.4/R.31/Add.4) Drivage, development and support of roadways and faces in deep mines and, consequently, in more difficult mining, geological and atmospheric conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 28 Jan 1986. 5p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

In Spanish mining the greatest difficulties are not caused by depth but by the following factors, either individually or in combination: great tectonization in the coalfields of Asturias, Northern Leon, Palencia, Penarroya, Pedroforca etc; highly irregular and for extreme formations in the coalfields of Cinana-Matallana and El Bierzo for example; self-combustion tendency in Teruel; great plasticity of the enclosing rock in Sabero and Teruel for example. The paper describes two of these factors in detail. These are mining of very wide, irregular seams in the Cinera-Matallana coalfield and self-combustion of lignite from the Innominada mine in the Teruel coalfield. In Spain, development of heading mechanization has taken place and the paper describes one of the most important achievements in this field. This is the WVR-4.7 shielded mole which is a full section-combined loading and stoping machine designed for mines. The main design characteristic is that the stoping face working area is occluded in two shields that cover it completely, allowing transit through difficult areas, such as faults and coal seams, with great safety for staff and with no coal cave-in problems.

19939 **(ECE—COAL/GE.4/R.31/Add.3) Drivage, development and support of roadways and faces in deep mines and, consequently, in more difficult mining, geological and atmospheric conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 27 Jan 1986. 4p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper considers the progress in updating and utilizing mining equipment, particularly in the case of mechanised face crossings, achieved in the Velenje lignite mine in Yugoslavia. Topics covered are: construction of face crossings in difficult mining and geological conditions; new working technology in longwall face crossings; analysis of working technology in the mechanised crossings. The paper also considers the study of exploitation in the areas of sudden coal and gas outbursts again using the Velenje lignite mine as an example. Work has been and will be devoted to two aspects of the study. These are the investigations of the possibilities of prognosticating the hazardous areas in which precautions for outbursts preventing should be taken or at least for reducing their detrimental consequences, and the prevention of outbursts and reduction of their noxious consequences.

19940 **(ECE—COAL/GE.4/R.29/Add.4) Activities of the National Mining Research Institute of ECE countries and exchange of scientific, technical and economic information relating to the coal industry.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 24 Jan 1986. 3p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper describes the work and development work being carried out in Yugoslavia. This is financed by the Research Community (Community for Science) and directly by the coal mines. The action of the mining institutes that carry out this research is directed towards the aim of improving or modifying the technology for underground mining. The main areas of research are as follows: geostatistical method of coal reserve estimation; lignite winning technology; coal gasification; in-situ lignite gasification; mechanization and automation of longwall face production; safety; in-situ methods for determining rock characteristics and drying and briquetting of lignites.

19941 **(ECE—COAL/GE.4/R.29/Add.3) Activities of the National Mining Research Institutes of ECE countries and exchange of scientific, technical and economic information relating to the coal industry.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 23 Jan 1986. 11p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper describes the six centres that do research work on coal in Spain and explains this diversified research structure and its degree of coordination. These centres are as follows: the Geological and Mining Institute of Spain which has three subdivisions: Basic Geology and Techniques, Ground Water and Geotechnology, and Mineral Resources; the National Coal Institute, and Zaragoza Carbochemical Institute which has three departments - preparation, assessment of properties and processing; Madariaga Official Laboratory for the Testing and Inspection of Electrical Equipment for Explosive Atmospheres and of Mining Equipment; Adaro National Mining Research Corporation; Association for Technological Research on Mining Equipment; National Silicosis Institute. The statutes, corporate aims, organization and major fields of activities of each of the institutions is described in detail and supranational and international cooperation is outlined.

19942 **(ECE—COAL/GE.4/R.29/Add.1) Activities of the National Mining Research Institutes of ECE countries and exchange of scientific, technical and economic information relating to the coal industry.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 14 Jan 1986. 8p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper reviews the activities of CERCHAR (Study and Research Centre of the French National Coal Board) which still devotes a large share of its activities to mining operations, although in recent years coal utilization techniques have grown in importance. However the basic objectives of improved safety, working conditions and results remain unchanged: Topics covered are: mining safety and techniques, including the use of high-pressure water jets for breaking up rocks, introduction of electronics in mines for remote control, optical fibres, mine ventilation systems, hygiene and working conditions, coal miner's pneumoconiosis and rock deformations during mining operations; scientific, technical and economic information on the coal mining industry, including the share of coal in the energy market in France in 1984, electricity generation, improvement in iron and steel industry, industrial, residential and tertiary sector, coal production, more modern mining, improved working conditions, investment, improvement of economic results and improvement of productivity.

19943 **(ECE—COAL/GE.4/R.20/Add.12) Improvement of reliability of opencast mining techniques in difficult geological, mining and climatic conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 13 Jan 1986. 7p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper considers the surface mining of coal in France and uses the Cevennes coalfield, which displays some difficult geological and mining conditions, as a typical example to show how the reliability of opencast techniques is being improved. Topics covered are a brief description of the type of deposits including geology, topography and environment and climate, mining methods and improvement of reliability of opencast techniques where slope stability is the main problem. Work on slope stability and blasting methods is considered where topics are initial geotechnical studies, need for monitoring and sounding of slopes including overall monitoring of the entire mine, monitoring of unstable zones and predicting ruptures and blasting methods and the procedure to preserve stability of the slopes including pre-splitting, cushion blast and coaling blast. The effect of climatic conditions on opencast mining is also discussed.

19944 **(ECE—COAL/GE.4/R.31/Add.2) Drivage, development and support of roadways and faces in deep mines and consequently in difficult mining, geological and atmospheric conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 13 Jan 1986. 4p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper concerns the difficulties of the increasing depth of mine workings in France. The three main aspects of this are rising temperature, rising rock pressure and distance of faces from the shaft bottom. Topics covered are: current research on hot faces in the cases of faces and headings; attempts to improve support systems in order to combat rising rock pressure in the cases of roadways, dense and deep deposits, very thick veins and faces; improvements in communications and transport as a result of the increase in the depth of workings and the distance of faces from the shaft bottom. The paper concludes that important advances have been achieved in many different types of deposit and under widely varying working conditions, and therefore these are likely to be taken up on a large scale.

19945 **(ECE—COAL/GE.4/R.20/Add.6/Supp.1) Improvement of reliability of opencast mining techniques in difficult geological, mining and climatic conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 19 Nov 1985. 4p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper represents an addition to the report on surface mining presented by the Government of Czechoslovakia at the Seventh Meeting of Directors. The report concerned the principal features of the measurement methods used at opencast mines in Czechoslovakia. Topics covered in the paper are stability of pits and dumps system for monitoring the outer slopes of pits, detection of refractory inclusions, determination of cutting effort on mining equipment and radioisolation methods, using radioisotopes, of collecting data on the drainage of mine workings.

19946 **(ECE—COAL/GE.4/R.20/Add.7/Sup.1) Improvement of reliability of opencast mining techniques in difficult geological, mining and climatic conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 19 Nov 1985. 4p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper considers the further development of brown coal mining at opencast sites in the German Democratic Republic. This is marked by an increase in output and by operation under even more complex geological and hydrological conditions associated with complex soil mechanics and an increase in mining depth. There are three main areas in which the reliability and availability of opencast mining equipment has been increased these are as follows: automation of technical operations at opencast mines including automation of excavators and spoil stackers by computer-programmed control and automation of drainage. Improved reliability of equipment and installations; stabilization of opencast excavators and installations in difficult in climatic conditions.

19947 **(ECE—COAL/GE.4/R.20/Add.11) Improvement of reliability of opencast mining techniques in difficult geological, mining and climatic conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 19 Nov 1985. 3p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper considers surface mining of brown coal in Yugoslavia. Yugoslavia processes large brown coal reserves with very favourable geological conditions for surface mining reflected in great seam thickness, horizontal or mildly dipping position of usually only a single seam and uniform grade of coal. This means highly favourable techno-economic conditions for cheap exploitation. However land configuration and poor geomechanical properties of hanging wall strata cause problems at larger depths related to the formation of outside disposal areas, delayed transfer to internal dumping and the maintenance of open pit slopes. The paper outlines the problems of the disposal of large amounts of overburden and environmental effects, the instability of final pit slopes primarily due to the geomechanical properties of the yellow and grey hanging wall clays, and the effects of atmospheric precipitations. Investigations and geomechanical calculations being carried out are considered, these have the aim of constructing safer lateral and final slopes. Solutions developed for the formation of future disposal areas and investigations into the formation and alternative disposal of the overburden are discussed.

19948 **(ECE—COAL/GE.4/R.22/Add.12) Authority and responsibility of advisory bodies and project assessment procedures to support decisions on research and development priorities and programmes.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 19 Nov 1985. 2p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

After World War II the Yugoslav institutions were incapable of developing scientific work in the mining industry due to lack of laboratories, resources and personnel, with the situation in mines worse due to the scarcity of professional staff to carry out research work. Subsequently departments with the objectives of studying current problems were set up. There was a need to introduce technological solutions at a higher technical level into the Yugoslav mining industry which was lagging behind and hence the necessity of establishing scientific institutions to deal with research in the mining industry was felt. Research and development in the Yugoslav coal industry is performed by four independent institutes, however there is no single body to coordinate them. The paper describes the operation of these institutes and the way that research and development is controlled by them.

19949 **(ECE—COAL/GE.4/R.20/Add.5/Suppl.1) Improvement of reliability of opencast mining techniques in difficult geological, mining and climatic conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 11 Oct 1985. 12p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper provides additional information on the improvement of surface mining techniques in the United Kingdom and has been prepared as a supplement to the sections of the report submitted by the Opencast Executive of the National Coal Board, for the seventh Meeting of Directors of National Mining Research Institutes held in May 1984, where further developments have taken place. Topics covered are rock quality evaluation for efficient blast design, development of improved blast monitoring equipment, radio-telemetry, ROC-TEC - a technique for obtaining continuous, accurate rock strength and fracture data and environmental monitoring stations.

19950 **(ECE—COAL/GE.4/R.20/Add.9) Improvement of reliability of opencast mining techniques in difficult geological, mining and climatic conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 11 Oct 1985. 2p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper considers the improvement of reliability of surface mining techniques in Hungary. Geological problems encountered in opencast exploitations are generally less serious than in underground mines; however, climatic difficulties have to be faced. Improving the reliability of opencast technologies is aimed in the first place at realizing as soon as possible the return of investments and increasing efficiency, while taking account of extreme climatic and geological conditions. Dewatering is important in surface mining as well as continuous work on improving equipment and its reliability. Another way to improve reliability of surface mining is by more rapid surveying work using aerial photographs. Training is also necessary to improve workers' skills.

19951 **(ECE—COAL/GE.4/R.20/Add.10) Improvement of reliability of opencast mining techniques in difficult geological, mining and climatic conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 11 Oct 1985. 4p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper considers the regularity of strip mining in Spain. The three objectives concerned are regularity of tonnage produced; regularity of ore grade and regularity of ore distribution in space and time. It is obvious that achieving these objectives is difficult in Spain where the weather, mining and geological conditions are bad. However as a result of research and development two strip-mining models have been arrived at. The first model is the open bucket-wheel conveyor method to mine brown coal and the second is the falling benching method with conventional mining equipment to mine bituminous coal, anthracite and black lignite. The prior to mining requirements for obtaining regularity in the tonnage, the determination of ore grade and variations in ore distribution due to geologic factors are also discussed.

19952 **(ECE—COAL/GE.4/R.22/Add.9) Authority and responsibility of advisory bodies and project assessment procedures to support decisions on research and development priorities and programs.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 11 Oct 1985. 7p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper describes changes that have occurred in coal research and development management in Spain since 1983. These are in chronological order. Topics covered are: 1984-National Energy Plan advisory group on coal research and development, including background to the plan and funding, criteria followed; projects studied and approved, conclusions on achievement of objectives and formation of an association with the exclusive object of managing and financing coal research and development; 1985-Ministry Order on the granting of subsidies to finance mining technology research and development activities, including preamble, objectives, priorities, beneficiaries and follow-up and control; formation of OCICARBON (a management association set up to manage R & D activities) in February 1985; relations between central Government and OCICARBON.

19953 **(ECE—COAL/GE.4/R.22/Add.10) Authority and responsibility of advisory bodies and project assessment procedures to support decisions on research and development priorities and programs.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 11 Oct 1985. 3p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

As the research and development organization of Hungary's mining industry, the Central Institute for the Development of Mining (KBFI) undertakes work on a control basis for supporting decisions on development programmes relating to this sector of industry. It also has the task of taking initiatives to perform research and development work of technical, economic, organizatory or safety character or make investigations into the utilization of mineral resources. KBFI is a member of the mining union and its staff participate in the work of various scientific associations and organizations and pass judgement on decisions about important problems. The paper outlines the proposal by the KBFI for research and development priorities, the responsibilities of advisory bodies preparing proposals, decision making and use of a jury and the establishment of the Scientific Council.

19954 **(ECE—COAL/GE.4/R.22/Add.11) Authority and responsibility of advisory bodies and project assessment procedures, to support decisions on research and development priorities and programmes.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 11 Oct 1985. 3p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper considers the authority and responsibility of advisory bodies and project assessment procedures for coal mining research in France. The research is conducted mainly by CERCHAR - Study and Research Centre, French coal-mining industry. CERCHAR's policy, programme and budget are submitted for comment to a management committee of staff representatives, the coal mining industry and the Ministry of Industry and Research. There are three commissions that ensure coordination between the research workers and mine operators. The paper outlines the commissions and their links. These commissions still play an advisory role but two of them (CORT - technical research commission and COMPUT - technical committee for the preparation, utilization and processing of coal) have no decision making powers. However CORSS - Commission for Scientific Research and Safety in Mines and Quarries - has the power of decision to initiate and support the research which it finances. The paper outlines the preparation and considerations of project assessment procedures where projects are considered in the context of meetings on research or on programmes.

19955 **(ECE—COAL/GE.4/R.22/Add.8) Authority and responsibility of advisory bodies and project assessment procedures to support decisions on research and development priorities and programmes.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 27 Jun 1985. 3p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

This paper considers the authority and responsibility of the Board of the Steinkohlenbergbauverein of the Federal Republic of Germany to support decisions on research programs. It is difficult to obtain objective criteria for a standard assessment of all research and development projects of the coal mining industry as they are different. For example; mining - technological and process-engineering progress is aimed at rationalizing success and reduced costs while improved safety and environmental protection may even entail a cost increase. The Board of Steinkohlenbergbauverein, therefore, by means of a project synopsis decides on: fundamentals and safety; mining technology; utilization and conversion of coal and distribution of funds among these. The paper outlines the tasks of the committees of Steinkohlenbergbauverein including exchange of professional experience within the industry as well as co-ordination and expert guidance and control of research and development work within the hard coal mining industry. The activities of the committees recorded positive results in several tasks which are outlined in the paper. The paper concludes that the committee system was a valuable instrument for determining research priorities within the coal industry.

19956 **(ECE—COAL/GE.4/R.31/Add.1) Drivage, development and support of roadways and faces in deep mines and consequently in more difficult mining, geological and atmospheric conditions.** (United Nations, Geneva (Switzerland). Economic Commission for Europe). 20 Nov 1983. 1p. (CONF-8605233—). IEA Coal Research, London SW1W OEX, England.

From 8. meeting of directors of National Mining Research Institutes; Oviedo, Spain (12 May 1986).

The United Kingdom's experience in operating deep longwall faces is limited to one face at a depth of 1088 m. Present forecasts for mining at depths greater than 1000 m indicate that it will be 15 years or more before the proportions are increased.

## 0130 Transport And Handling

19957 **(CONF-8610220—3) Development, evaluation, and testing of an active ultrasonic cross-correlation coal-slurry flowmeter.** Sheen, S.H.; Bobis, J.P.; Raptis, A.C. (Argonne National Lab., IL (USA)). Oct 1986. Contract W-31109-ENG-38. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004854.

From DOE contractors meeting; Pittsburgh, PA, USA (21 Oct 1986).

This paper describes the development of an active ultrasonic cross-correlation flowmeter at Argonne National Laboratory (ANL). The flowmeter includes transducer standoffs for high-temperature application, an integrated electronic package for signal generation and conditioning, and data processing software operating on an IBM-AT computer. The flowmeter has been tested for coal/water and coal/oil slurries over a wide range of concentration at the ANL Solid/Liquid Flow Test Facility (SLFTF) and at the SRC-1 coal-slurry feedline. Test results leading to the selection of standoff design, operating frequency, signal filtering, and transducer spacing are discussed. Flowmeter performance is evaluated in terms of accuracy, response time, and consistency. 6 refs., 11 figs.

19958 **(DOE/PETC/TR—87/7) Analysis of fine coal pneumatic systems.** Mathur, M.P.; Rohatgi, N.D.; Klinzing, G.E. (USDOE Pittsburgh Energy Technology Center, PA; Pittsburgh Univ., PA (USA). Dept. of Chemical and Petroleum Engineering). Jan 1987. 164p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE87006301.

Many fossil fuel energy processes depend on the movement of solids by pneumatic transport. Despite the considerable amount of work reported in the literature on pneumatic transport, the design of new industrial systems for new products continues to rely to a great extent on empiricism. A pilot-scale test facility has been constructed at Pittsburgh Energy Technology Center (PETC) and is equipped with modern sophisticated measuring techniques (such as Pressure Transducers, Auburn Monitors, Micro Motion Mass flowmeters) and an automatic computer-controlled data acquisition

system to study the effects of particle pneumatic transport. Pittsburgh Seam and Montana rosebud coals of varying size consist and moisture content were tested in the atmospheric and pressurized coal flow test loops (AP/CFTL and HP/CFTL) at PETC. The system parameters included conveying gas velocity, injector tank pressure, screw conveyor speed, pipe radius, and pipe bends. In the following report, results from the coal flow tests were presented and analyzed. Existing theories and correlations on two-phase flows were reviewed. Experimental data were compared with values calculated from empirically or theoretically derived equations available in the literature, and new correlations were proposed, when applicable, to give a better interpretation of the data and a better understanding of the various flow regimes involved in pneumatic transport. 55 refs., 56 figs., 6 tabs.

19959 **(EPRI-CS—5053) Coal-water-slurry transportation alternatives: Final report.** Buls, R.L.; Grant, B.E.; Kniffen, S.J.; Roeger, A. III; West, R.B. (Texas Eastern Engineering Ltd., Houston (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 267p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920270.

This study evaluates the technical and economic parameters associated with transporting a characteristic coal-water-slurry fuel (CWSF) from hypothetical manufacturing plants to existing electric utility plants. The transportation modes evaluated were: (1) railroad trains, (2) highway haulage trucks, (3) intercoastal, river and ocean-going barges, and (4) overland pipelines. The results of this investigation demonstrate that, for commercial operation, CWSF may be transported by any one of the four transportation systems. However, the handling facilities, transport vessels, pumps, piping, valves, and associated equipment must be designed to meet specifications dictated by the physical and chemical properties of a particular slurry being transported. The best transportation system for a given service is a function of transport system availability and overall system economics. This study identified four types of guidelines which will aid in development of an acceptable transportation mode for a given commercial project. These guidelines cover: (1) CWSF data base development, (2) CWSF handling equipment selection, (3) CWSF transportation equipment selection, and (4) preliminary CWSF transportation mode selection. 121 refs., 45 figs., 102 tabs.

## 0140 Combustion

*REFER ALSO TO CITATION(S) 19891, 19895, 19935, 19936, 19942, 20310*

19960 **(DOE/PC/70268—T1-Vol.1) Fundamental aspects of coal-water fuel droplet combustion and secondary atomization of coal-water mixtures: Final report: Volume 1.** Kang, S.W.; Sarofim, A.F.; Teare, J.D.; Beer, J.M. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Feb 1987. Contract FG22-84PC70268. 89p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87005397.

This Final Report is issued in two volumes, covering research into the combustion of coal-water fuels. Two separate but related tasks are discussed: Volume I, contains results obtained under Task 1 - "Fundamental Aspects of Coal-Water Fuel Droplet Combustion"; Volume II describes the work of Task 2 - "Secondary Atomization of Coal Water Mixtures," which included experimental measurements in a Spray Test Facility and in the 1 to 3 MW/sub th/ Combustion Research Facility. The processes of devolatilization and char combustion were studied in a laminar flow reactor (LFR) by two experimental procedures. In the first of these, a CWF droplet generator was developed and used to feed CWF droplets directly into the LFR. The CWF droplet generator, which consists of a twin-fluid, internally-mixed atomizer and a series of skimmers to reduce the feed rate of droplets into the LFR, is capable of producing CWF droplets in the size range of 5 to 500 micrometers at feed rates of less than 3 mg/sec. In the second parallel study, solid samples withdrawn from a CWF spray flame, close to the atomizing nozzle, were size graded and fed into the LFR in low particle concentrations. Their combustion history in the LFR was determined by monitoring the intensity of radiation emitted by individual particles during combustion (by two-color pyrometry) and by the use of high speed cinematography. The study has established the importance of rotation induced by the volatile evolution on the break up of coal-aggregates and the release of ash particles. 24 refs., 25 figs.

19961 **(DOE/PC/70268—T1-Vol.2) Fundamental aspects of coal-water fuel droplet combustion and secondary atomization of coal-water mixtures: Final report: Volume 2.** Yu, T.U.; Kang, S.W.; Beer, J.M.; Teare, J.D.; Sarofim, A.F. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Feb 1987. Contract FG22-84PC70268. 57p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87005398.

This Final Report is issued in two volumes, covering research into the combustion of Coal Water Fuels (CWF). The present report, Volume II, covers experiments under Task 2 - "Secondary Atomization of Coal-Water Mixtures." Three methods of improving spray fineness by fuel treatment were investigated - (1) the heating of the CWF under pressure to produce steam as the pressure drops during passage of the CWF through the atomizer nozzle, (2) the absorption of $CO_2$ gas in the CWF to produce a similar effect, and (3) the addition of a chemical additive which will cause microexplosions in the droplets upon heating. The effects of disruptive atomization upon CWF spray size distribution were studied using a spray test chamber equipped with a laser diffraction particle size analyzer; the data were fitted to the Rosin-Rammler particle size distribution function. The combustion characteristics of the treated CWFs were investigated in the MIT Combustion Research Facility. The spray chamber tests established that thermally-assisted atomization produced reductions both in the mean droplet size and in the mass fraction of large particles in the spray. For fuel delivery temperatures up to 100°C this effect is attributable to lowered fuel viscosity, while further heat of the CWF (to 150°C in these experiments) produces disruptive atomization. In-flame measurements and high speed cine pictures made during combustion tests provided detailed information for comparisons of treated and untreated CWF. Thermally-assisted atomization was the most effective of the methods studied for improving carbon conversion efficiency and reducing fly ash particle size. $CO_2$ and picric acid addition techniques showed substantial improvements but they were less effective. 13 refs., 15 figs., 14 tabs.

19962 (DOE/PC/70771—T4, pp 3.1-3.27) **Nitrogen reactions in pulverized coal combustion: Mechanisms governing the fate of coal nitrogen during the staged combustion of high and low rank pulverized coals.** Bose, A.C.; Kannecker, K.M.; Wendt, J.O.L. (Arizona Univ., Tucson). [1987]. NTIS, PC A04/MF A01. File Number DE87005647.

In Kinetics of nitrogen and sulfur reactions in combustion systems: Quarterly report No. 6.

Chemical kinetic mechanisms governing the destruction of NO in the fuel rich stage of a pulverized coal staged combustion process were investigated. Emphasis was on the effects of temperature, coal rank and stoichiometric ratio on the speciation and rates of destruction of NO, HCN and $NH_3$. Experiments on eight coals, burned in a 2 kg/h downflow combustor, yielded time resolved profiles of temperature, major species and minor species. These profiles allowed global mechanisms describing the destruction of NO to be explored, using models of three levels of sophistication. The simplest model, that of Fenimore, allowed data from each coal to be correlated, but discrepancies from coal to coal were apparent. The next model attempted to predict measured NO profiles using previously determined rate coefficients and three homogeneous reactions destroying NO by reaction with NH/sub i/ (i = 0,1,2). This also led to some discrepancies, which are described in detail. The last level of sophistication involved consideration of reactions between NO and hydrocarbons. Additional experimentation was conducted to explore this interaction, and modeling is still in progress. 9 refs., 10 figs., 2 tabs.

19963 **(EPRI-CS—5070) Bench-scale combustion characterization of cleaned Kentucky No. 9 coals: Final report.** Smouse, S.M. (Babcock and Wilcox Co., Alliance, OH (USA). Research and Development Div.; Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 69p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920277.

Many previous studies have attempted to quantify the effects of coal quality on power plant performance to justify use of cleaned coal. These studies indicated that the use of cleaned coal can improve reliability, increase availability, and reduce maintenance costs. However, the cost/benefit advantages of cleaned coals have not been clearly demonstrated to utilities. The Electric Power Research Institute has launched a program to evaluate the effects of coal quality on power plant performance. This project was designed to study combustion characteristics of raw and cleaned coals. To evaluate and demonstrate the relative merits of clean coal versus raw coal to electric utilities, it is necessary to test and compare the properties and characteristics of both types of coals. The areas of major interest include grindability and abrasion behavior, ignitability and combustion efficiency, slagging and fouling potential, sulfur and nitrogen oxides emission potential, and fly ash collection efficiency. The properties and characteristics of two levels (medium and deep) of cleaned Kentucky No. 9 coal were tested and compared to those of the raw coal. The cleaned coals were prepared at EPRI's Coal Cleaning Test Facility (CCTF) at Homer City, Pa. The test results indicate that certain advantages, in addition to reducing sulfur oxides emissions, can be attained by coal cleaning. Use of cleaned Kentucky No. 9 coals in existing units will allow the following improvements to be realized: increased pulverizer grinding element lives, reduced pulverized-coal and fly ash erosion, and reduced particulate emissions potential. It appears that there are significant advantages in using the cleaned Kentucky No. 9 coals. However, other cleaned coals may not show similar advantages, and the costs/benefits of using cleaned coals must be assessed on an individual basis. 15 refs., 5 figs., 14 tabs.

19964 **(TURVOP—44) Instrumentation, control and simulation of peat fuelled plants.** Kortela, U.; Lehtomaeski, K.; Luukkanen, J.; Majanne, Y.; Luntta, E. (Tampere Univ. of Tech. (Finland)). Feb 1984. 72p. (In Finnish). NTIS.

The research of the instrumentation, control and simulation of peat fuelled plants consists of the four following parts: development of simulation models for peat fuelled power plants, research of the possibilities of developing instrumentation in power plants, development of compensation methods for fuel quality variations and control of fuel feed and drying, economic comparison of peat power plants and availability and reliability study of peat handling and drying equipments. In the simulation study a nonlinear mathematical model for a peat power plant was constructed. A modular simulation package suitable for development of control strategies and for analysing the properties of power plants was constructed on the basis of the model. Oxygen and carbon-monoxide sensors and flame detection sensors were studied and their use for control purposes was examined. A device for peat moisture measurement was constructed to compensate the errors and disturbances of earlier methods. Development work for control strategies to compensate disturbances in fuel and quality variations of a nonhomogeneous fuel was continued. A hierarchical control strategy for multifuel multi-boiler systems was constructed. In the economic comparison, energy production costs of different types of power plants were studied. Availability and reliability study of fuel handling systems, separate equipment and drying systems produced information for the construction design of new plants.

### 0150 Marketing And Economics

*REFER ALSO TO CITATION(S) 19896, 20459*

### 0160 Health And Safety

*REFER ALSO TO CITATION(S) 19912, 19941*

### 0170 Legislation And Regulations

*REFER ALSO TO CITATION(S) 19925*

## 02 PETROLEUM

### 0202 Geology And Exploration

*REFER ALSO TO CITATION(S) 19974, 21272, 21280*

19965 **Shear wave transducer for stress measurements in boreholes.** Mao, N.H. (to Dept. of Energy, Washington, DC). US Patent 4,641,520. 10 Feb 1987. Filed date 23 Aug 1984. vp.

A method is described for determining stress around a borehole, comprising: generating a radially polarized shear wave in the borehole at two positions spaced apart by 90°; transmitting the radially polarized shear waves in a direction along the borehole; measuring the velocity of the radially polarized shear waves; generating a tangentially polarized shear wave in the borehole at two positions spaced apart by 90°; transmitting the tangentially polarized shear waves in a direction along the borehole; measuring the velocity of the tangentially polarized shear waves; calculating the stress induced shear wave velocity anisotropy from the measured velocities; and calculating the stress from the shear wave velocity anisotropy according to a predetermined relationship.

19966 **Updated DOE data bank.** Ray, R.M. (Dept. of Energy, Bartlesville). *Interstate Oil Compact Commission Committee Bulletin;* **27**: No. 2, 1-11(Dec 1985).

DOE support of the Interstate Oil Compact Commission study of incentives for EOR activities includes providing models and data bases which are part of an analytic system called Tertiary Oil Recovery Information System, or TORIS. This paper describes the background and context of TORIS and highlights the contents and coverage of the TORIS reservoir data base. An assessment is made of the most feasible targets for more intensive technology developments.

19967 **Generation and migration of hydrocarbons in Upper Cretaceous Austin Chalk, South-Central Texas.** Grabowski, G.J. Jr. (Exxon Production Research Co., Houston, TX). pp 97-116 of Petroleum geochemistry and source rock potential of carbonate rocks. Palacas, J.G. Tulsa, OK; American Association of Petroleum Geologists (1984).

This study of the organic geochemistry of the Austin Chalk bears on three aspects of fine-grained organic-rich carbonate rocks: the distribution of organic matter, the effects of minerals on kerogen alteration and hydrocarbon generation, and the controls on migration and its effects on composition of EOM.

19968 **The Cretaceous Austin Chalk of South Texas - A petroleum source rock.** Hunt, J.M.; Mc Nichol, A.P. (Woods Hole Oceanographic Institution, Woods Hole, MA). pp 117-126 of Petroleum geochemistry and source rock potential of carbonate rocks. Palacas, J.G. Tulsa, OK; American Association of Petroleum Geologists (1984).

Carbonate rocks commonly have been discounted as important source rocks because of their lower organic-carbon content and lower catalytic activity in comparison to shales. However, carbonate source rocks contain mostly sapropelic organic matter, which yields a higher percentage of oil earlier than the more humic organic matter of shales. Furthermore, carbonate source-reservoir sequences are at many places overlain by the perfect seal, evaporite, during the time of oil generation and accumulation. In contrast, many sandstone-shale sequences tend to leak petroleum during and after accumulation. The richest source rocks in the world are the argillaceous and siliceous carbonates in formations such as the

Green River of Utah, the La Luna of Venezuela, and the Nordegg of the Western Canada basin.

## 0203 Drilling And Production

*REFER ALSO TO CITATION(S) 19902, 20002*

**19969 (CONF-8606270—1) Sacrificial agents for micellar-flooding enhanced oil recovery.** Johnson, J.S. Jr.; Jones, R.R.M. (Oak Ridge National Lab., TN (USA); Wake Forest Univ., Winston-Salem, NC (USA). Dept. of Chemistry). 1986. Contract AC05-84OR21400. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002175.

From Surface activity, colloid and interfacei property and industrial applications conference; Belgirate, Italy (9 Jun 1986).

The enormous potential of increasing recoverable petroleum reserves by micellar flooding is not yet realized. Costs of the chemicals and disappointing performance in field pilots, particularly in formations where the aqueous phase is of high salinity or hardness, have been the main barriers to implementation. Loss of chemicals by adsorption on formation minerals and by precipitation by multivalent counterions increase the amounts that must be used and make difficult maintenance of chemical compositions optimal for displacement. Preflushes with agents that preferentially adsorb or that sequester multivalent cations might alleviate these problems. Wastes or low- value byproducts from the pulping of wood by the kraft process are shown to decrease the loss of surfactants from solutions in contact with minerals present in oil-bearing formations. Of these, weak black liquor (spent digestion fluid), caustic extract from bleaching of pulp, and sodium saccharinates seem particularly interesting. These should be available in sufficient quantity and at low enough cost to be feasible for use. 23 refs., 17 figs., 2 tabs.

**19970 (DOE/BC/10852—1) Proceedings of the first international MEOR [Microbial Enhanced Oil Recovery] workshop.** King, J.W.; Stevens, D.A. (eds.). (Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center). Jan 1987. Contract AC19-85BC10852. 375p. (CONF-8604299—). NTIS, PC A16/MF A01. File Number DE87001216.

From 1. international MEOR workshop; Abilene, TX, USA (1 Apr 1986).

The proceedings includes the following parts: (1) list of panelists and group leaders; (2) opening remarks and introduction; (3) panel presentation - "geological and engineering evaluation of MEOR"; (5) panel presentation - "specific applications of MEOR"; (6) report from workshop groups; and (7) final session (conclusions and recommendations). Selected papers have been processed for inclusion in the Energy Data Base.

**19971 (DOE/MC/20338—2287) Development of a generalized hydraulic fracture model: [Annual report] for the period November 1, 1985-October 31, 1986.** Advani, S.H.; Lee, J.K. (Ohio State Univ., Columbus (USA)). Oct 1986. Contract AC21-83MC20338. 93p. NTIS MF A01; 2; GPO Dep. File Number DE87006425.

The research tasks and accomplishments reported here represent a major contribution towards the rational development of a comprehensive simulator for hydraulic fracture processes. In particular, formulations and results from one-dimensional and advanced finite element simulations are presented. The developed model yields reasonable comparisons with published results on fracture length, height, and width for reservoirs with symmetric and unsymmetric in situ stress distributions. Problems associated with symmetric material property contrasts and vertical height penetration criteria are also detailed. The in situ stress analysis program can be used as a predictive tool for examining principal stress variations in reservoirs. Subsequent Mohr-Coulomb-Griffith failure analyses can identify potential naturally fractured regions and the orientations of these tectonically relaxed fracture systems. The fundamental solutions for the penny-shaped and elliptical crack models provide an economical framework for conducting parametric-sensitivity design studies. In addition, the validation of sophisticated numerical codes is facilitated. The non-Newtonian fracture fluid leak-off investigations furnish basic insight on the role of the power law exponent of pseudo-plastic type fluids. The inclusion of these non-Newtonian characteristics in the governing mass conservation equation is warranted since the leak-off expression is substantially modified. Finally, the judicious coupling of the induced hydraulic fracture geometry with a compatible reservoir model represents a logical step towards an integrated systems approach for optimum resource extraction. 11 refs., 2 figs., 2 tabs.

**19972 (DOE/METC—87/6073, pp 223-238) Phase behavior of light hydrocarbon - heavy oil or tar systems and its application to recovery processes.** Jacoby, R.H. (Colorado School of Mines, Golden, CO). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The effect of dissolved light hydrocarbons as ethane, propane, and butane on the viscosity and solids precipitation behavior of heavy oils and Athabasca tar is shown from experimental data. These data are compared with commonly held notions of such behavior and explained in more general terms. This information may be used to advantage in recovery processes for heavy oils or tars, and the results of one field test are shown as an example. 7 references, 15 figures, 2 tables.

**19973 (NIPER—179) Significance of the survival and performance of Bacillus species in porous media for enhanced oil recovery: Topical report.** Bryant, R.S.; Douglas, J. (National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)). Mar 1987. Contract FC22-83FE60149. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001226.

Microbial enhanced oil recovery (MEOR) technology has advanced to the stage in which several field tests have been performed, with others still in progress. The potential for microbial injection into petroleum reservoirs to cause environmental problems has not been determined. Ongoing research at NIPER has placed emphasis upon determining whether MEOR processes can be used safely and successfully in oilfields. Two microorganisms used frequently for MEOR field projects are Clostridium and Bacillus spp. This report presents data on several species of Bacillus and their characteristics in porous media, their compatibility with other microbial species, and their oil recovery efficiencies. Significant findings included the following: (1) Contaminating microorganisms from nutrients or the reservoir can interfere with Bacillus species. (2) Many Gram-negative bacteria overgrow Bacillus spp. after 1 week residence time in porous media. (3) Bacillus species can, because of their spore formation, survive in porous media for almost 7 months without additional nutrients. It was concluded that the compatibility of MEOR microorganisms to be injected and field microbial flora and fluids must be determined before field testing. Bacillus appears to behave more consistently in porous media and with other microorganisms than the Clostridium species investigated in last year's work. 3 refs., 1 fig., 6 tabs.

**19974 Methods for enhancing mapping of thermal fronts in oil recovery.** Lee, D.O.; Montoya, P.C.; Wayland, J.R. Jr. (to Dept. of Energy, Washington, DC). US Patent 4,641,099. 3 Feb 1987. Filed date 30 Mar 1984. vp.

A method is described for enhancing the resistivity contrasts of a thermal front produced by enhanced oil recovery techniques in a production field, to allow its detection by a controlled source audio frequency magnetotelluric (CSAMT) technique, comprising the steps of: (a) preparing a CSAMT-determined topological resistivity map of the production field; (b) injecting a solution of a dopant material into the production field at a concentration effective to alter the resistivity associated with the thermal front; the dopant material having a high cation exchange capacity and being soluble in the conate water of the production field; (c) preparing a CSAMT-determined topological resistivity map of the production field while the dopant material is moving therethrough; and (d) mathematically comparing the maps from step (a) and step (c) to determine the location of the thermal front.

19975 **Life models for small-diameter polycrystalline diamond compact bits in hard abrasive media.** Hough, C.L. Jr.; Das, B.; Rozgonyi, T.G. (Dept. of Mechanical Engineering, Texas A & M Univ., College Station, TX 77843). *Journal of Energy Resources Technology;* **108**: No. 4, 310-314(Dec 1986).

Mathematical models for bit life of polycrystalline diamond compact (PDC) drill bits were developed for drilling in hard abrasive media. Based on the wear-out criterion of an average 0.060 in. (1.5 mm) flank wear land, bit life equations were formulated in three forms: bit life versus rotary speed and feed rate, bit life versus rotary speed and penetration rate, and wear rate versus cutting speed and cutter engagement area. The traditional linear-logarithmic model provided the best bit life prediction equation. Consequently, it would be possible to predict the optimum economical drilling conditions more accurately by employing a quadratic-logarithmic based bit life equation. The equation demonstrated the ability to predict the bit life precisely under different modes of wear.

## 0205 Products And By-products

*REFER ALSO TO CITATION(S) 20033, 20165*

19976 **(AD-A—175357/3/XAB) Substitution of fog oil with diesel fuel using a thermomechanical approach. Contractor report, August 1985-June 1986.** Sliepcevich, C.M.; O'Rear, E.A.; Lott, J.L. (Oklahoma Univ., Norman (USA)). Nov 1986. 67p. NTIS, PC A04/MF A01.

The primary objective of this work was to investigate the possibility of improving the quality (yield and persistence) of diesel fuel as a screening smoke by thermomechanical means such as controlling the degrees of superheat in the diesel fuel vapors and the rates of formation of condensation nuclei via nozzle design and mixing with ambient air. A smoke tunnel 42 inches in cross section and 16 feet long was constructed. The obscuring power of the smoke was quantified by measuring light transmitted by a helium-neon laser light source. Results of the work to date indicate that substantial improvement in the quality of diesel fuel smoke can be achieved by thermomechanical means. Dispersal of a solid such as talc in the diesel smoke also increased obscuration but no dramatically.

19977 **(AD-A—175363/1/XAB) CRC (Coordinating Research Council) octane number requirement survey.** (Coordinating Research Council, Inc., Atlanta, GA (USA)). Oct 1986. 71p. (CRC—548). NTIS, PC A04/MF A01.

In the thirty-ninth annual statistical survey of current-model vehicles conducted by the Coordinating Research Council, Inc., test data were obtained on 374 1985 model vehicles, including 309 US vehicles and 65 imported vehicles. Fifteen laboratories participated in this Survey. Maximum octane number requirements were determined by testing under part-throttle conditions, as well as at maximum-throttle. Requirements are expressed as the (R+M)/2 octane number, Research octane number, and Motor octane number of the reference fuel producing knock which was recurrent and repeatable at the lowest audible level. The primary analyses used in this report are based upon (R+M)/2 octane number requirements, rather than upon Research octane number requirements as in previous reports. Estimated octane number requirements for the US vehicles are weighted in proportion to the 1985 vehicle model production figures and, for the imported models, in proportion to import sales volume in the United States.

## 0207 Marketing And Economics

*REFER ALSO TO CITATION(S) 20470*

19978 **(ANL/CNSV—58-Vol.1) The petroleum problem: Managing the gap: Volume 1, Summary report.** Santini, D.J. (Argonne National Lab., IL (USA)). Aug 1986. Contract W-31109-ENG-38. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006187.

A 20th century historical study of the interactions of petroleum supply and demand patterns and subsequent macroeconomic events suggests that the often-erratic behavior of the oil markets consistently contributes to economic instability. The obvious depletion of US oil reserves and the increasing importance of oil consumption in US transportation are argued to be causes for greater attention to the development of alternative (non-oil based) transportation fuels. Absent such development, the historical lessons in this report suggest that another period of rising oil prices, erratic oil market behavior, and subsequent economic difficulty is probable within the next two decades. Methanol is argued to be the most likely and most desirable substitute transportation fuel, because it can be produced more economically and used more efficiently than gasoline when derived from the rapidly expanding worldwide supplies of natural gas.

19979 **(DOE/EI/19722—T1) A program to monitor No. 2 heating oil prices and bulk terminal stocks in the State of New Jersey: Final report.** Jarecki, L. (New Jersey Dept. of Energy, Newark (USA)). 1986. Contract FC01-85EI19722. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005435.

Eighteen retail fuel merchants and fourteen bulk terminal operators were contacted on a bi-weekly basis to furnish gross retail and wholesale prices of No. 2 heating oil; and bulk terminal operators were to furnish stock data as of the specified dates.

19980 **(DOE/EI/19723—T1) Wisconsin fuel oil price and inventory: Final report, 1985-1986 heating season.** Nichols, K.N. (Wisconsin Div. of State Energy and Coastal Management, Madison (USA)). 1986. Contract FC01-85EI19723. 13p. NTIS, PC A02. File Number DE87005436.

This grant was a renewal of the grant received last heating season with some modifications. Last heating season only the price and inventory of No. 2 fuel oil were monitored. Furthermore, the inventory figures were obtained from the residential suppliers from which price data was also obtained. This year the inventory figures were obtained from selected wholesalers and the inventories of No. 1 and No. 4 oil were monitored along with No. 2 oil.

19981 **(DOE/EI/19724—T1) State of Pennsylvania, 1985-1986 State Heating Oil Program.** (Pennsylvania Governor's Energy Council, Harrisburg (USA)). 30 Jul 1986. Contract FC01-85EI19724. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005434.

This report summarizes the findings of Pennsylvania's distillate fuel oil price and stock survey conducted during the 1985/86 heating season.

19982 **(DOE/EIA—0035(86/11)) Monthly energy review, November 1986.** (USDOE Energy Information Administration, Washington, DC. Office of Energy Markets and End Use). Nov 1986. 133p. NTIS, PC A07 - GPO. File Number DE87006355.

The Monthly Energy Review review presents current data on production, consumption, stocks, imports, exports, and prices of the principal energy commodities in the United States. Also included are data on international production of crude oil, consumption of petroleum products, petroleum stocks, and production of electricity from nuclear-powered facilities.

19983 **(DOE/EIA—0109(86/12)) Petroleum Supply Monthly, December 1986.** (USDOE Energy Information Administration, Washington, DC. Office of Oil and Gas). 24 Feb 1987. 113p. NTIS, PC A06/MF A01 - GPO; GPO Dep. File Number DE87006005.

Statistical data for 1986 emphasizes regional highlights. (PSB)

## 0209 Environmental Aspects

*REFER ALSO TO CITATION(S) 21121, 21132, 21232*

**19984 (AD-A—175181/7/XAB) Crowley Alden A-4 oil skimmer operational test report. Final report, 1 May-30 June 1986.** Borst, M. (Mason and Hanger-Silas Mason Co., Inc., Leonardo, NJ (USA)). Oct 1986. 72p. NTIS, PC A04/MF A01.

The Environmental Protection Agency (EPA) tested the Crowley Alden A-4 Oil Skimming System at its Oil and Hazardous Simulated Environmental Test Tank (OHMSETT) facility in Leonardo, N.J. This testing was sponsored by the Naval Civil Engineering Laboratory (NCEL). The tests were required as part of a Navy purchase to assure that the product met or exceeded specifications in an RFP issued in 1985. During these tests the skimmer recovered 2 to 3 gallons per minute (gpm) (7.5 to 11.4 liters per minute (1pm) ) of oil. There was little or no variation in oil recovery rate introduced by altering test conditions. In calm water, the skimmer recovery efficiency was minimally 85 to 95 %. Under wave conditions, the recovery efficiency was 65 to 75 %. The test program included measurement of the maximum pump rate of an ancillary double diaphragm pump. The greatest pump rate that should be expected is 70 to 80 18pm (18 to 21gpm). Lower capacities were measured with added head, but the pump performed equally well with DFM as with water. Overall, the skimmer met or exceeded the performance characteristics required for inner harbor use.

## 0220 Transport, Pipelines, And Handling

**19985 Evacuation of a residual oil pipeline by inert gas displacement.** Webb, S.; Bogucz, E.; Levy, E.; Barrett, M.; Snyder, C.; Waters, C. (Thermal Hydraulic Analysis Div., Sandia National Labs., Albuquerque, NM). *SPE (Society of Petroleum Engineers) Production Engineering;* **2**: No. 1, 45-50(Feb 1987).

This paper describes an analysis developed to model the inert gas displacement process for evacuating a high-pour-point oil from a long pipeline. The governing equations were derived from the basic conservation equations for mass, momentum, and energy. The resultant computer program accounts for such effects as pipeline elevation changes, laminar and turbulent oil flow, temperature-dependent oil viscosity, and heat loss from the oil to the ground. Results of computations for an 84-mile [135-km] residual oil pipeline operated by the Pennsylvania Power and Light Co. are presented and compared with pressure measurements obtained during a trial purge of the system. Calculations show that the minimum N/sub 2/ volume required for a successful pipeline evacuation increases considerably with increased delay time. In addition, theoretical results indicate that for this case, the pipeline purge operation must begin within 20 hours of a shutdown to avoid evacuation difficulties.

## 0230 Properties

*REFER ALSO TO CITATION(S) 19972*

**19986 (NIPER—222) Stability, compatibility, and related problems of additives in Naval distillate fuels derived from lower quality feedstocks.** Brinkman, D.W.; Stirling, K.Q. (National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)). Feb 1987. Contract FC22-83FE60149. 63p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87001223.

This report describes the first two years of a study co-sponsored by DOE and the US Navy to determine which antioxidant additives are most effective in delaying fuel degradation in a variety of middle distillate straight run/light cycle oil blends. In this study, straight-run middle distillate and catalytically cracked product were mixed at ratios of 85:15, 70:30, and 60:40, respectively. All of these blended fuels were immediately treated with commercially available additives. Usual dosages were 12 and 24 ppM (volume/volume). Stability testing and fuel characterizations performed at four different laboratories were used to evaluate the additives. Each laboratory used a different type of stability test. The characterization studies were performed to ensure that the base fuel blends tested were within the range allowed by MIL-F-16884H and to determine whether any of the additives would make the fuels unacceptable for Navy use. Because of the high degree of stability of several of the control (additive-free) fuels, it was difficult to differentiate additive effectiveness in these fuels. Some studies were performed to see if controlled aging techniques prior to actual stability testing could increase the amount of sediment in the fuel. Results indicated that this would increase sediment in some cases and would have no effect in others. Sample collection techniques at the refineries were also investigated. Both lined and unlined cans were used in these studies. In cases where control fuels exhibited instability, it was possible to demonstrate the relative effectiveness of the 12 stabilizer additives. Five of the additives (2, 3, 10, 11, and 12) have been shown to be superior to the remaining seven. However, all 12 will continue to be tested during the remainder of this study. 2 refs., 6 figs., 25 tabs.

**19987 Determination and structural characteristics of sulfur heterocycles in coal- and petroleum-derived materials.** Nishioka, M.; Lee, M.L.; Castle, R.N. (Dept. of Chemistry, Brigham Young Univ., Provo, UT). *American Chemical Society, Division of Petroleum Chemistry, General Papers, Preprints;* **31**: No. 3, 827-833(Sep 1986). (CONF-860911—).

From 192. American Chemical Society national meeting; Anaheim, CA, USA (7 Sep 1986).

In thermally cracked oils and coal-derived materials, multiring thiophenic compounds, polycyclic aromatic sulfur heterocycles (PASH), are especially abundant. Two important steps must be accomplished in order to determine the structures of PASH in these samples. The first is the isolation of PASH from other types of coexisting compounds. The second is the separation and identification of individual PASH. There is a greater number of possible isomers for the PASH than for the corresponding polycyclic aromatic hydrocarbons (PAH). After isolation of the PASH, capillary column gas chromatography (GC) using authentic standard compounds for reference is the most reliable method for analyzing these isomeric PASH. Recently, a rapid and non-discriminating method for the isolation of PASH from the aromatic fractions of complex mixtures was developed. This method is based on ligand exchange chromatography using silica gel impregnated with palladium chloride. In this paper, advantages and shortcomings of this method are discussed. This new isolation method was applied to coal- and petroleum-derived materials, and structures of many isomeric PASH in these samples were determined using GC and gas chromatography/mass spectrometry (GC/MS). Analytical methodologies for the detailed identification of complex PASH using selective stationary phases and aromatic ring number fractionation are also reported. Finally, the structural characteristics of the PASH identified in these coal- and petroleum-derived materials were investigated and compared with the PAH in the same or similar samples.

**19988 Polynuclear aromatic systems in petroleum.** Speight, J.G. (Western Research Institute, P.O. Box 3395, University Station, Laramie, WY). *American Chemical Society, Division of Petroleum Chemistry, General Papers, Preprints;* **31**: No. 3, 818-825(Sep 1986). (CONF-860911—).

From 192. American Chemical Society national meeting; Anaheim, CA, USA (7 Sep 1986).

Polynuclear aromatic systems occur naturally in a variety of forms but one source which is often not recognized is petroleum. The higher molecular weight fractions of petroleum have a higher degree of aromaticity than the lower molecular weight fractions. In fact, the fraction known as asphaltenes is believed to contain highly complex polynuclear aromatic systems (references). The object of this paper is to briefly review the evidence that has been produced for the occurrence of polynuclear aromatic systems in petroleum asphaltenes and the degree of condensation of the aromatic ring systems. New data are also presented which provide indications of the ring-size distribution in petroleum asphaltenes. The evidence is accumulated by asphaltene fractionation and subsequent examination of the fractions by high performance liquid chromatography using an ultraviolet detector.

19989 **GC/MI/FTIR applications: Analysis of fossil fuels.** Schneider, J.F.; Boparai, A.S.; Raphaelian, L.A. (Analytical Chemistry Lab., Chemical Technology Div. Argonne National Lab., Argonne, IL). *American Chemical Society, Division of Petroleum Chemistry, General Papers, Preprints;* **31**: No. 3, 699(Sep 1986). (CONF-860911—).

From 192. American Chemical Society national meeting; Anaheim, CA, USA (7 Sep 1986).

Capillary-column gas chromatography interfaced with Fourier transform infrared spectrometry (GC/IR) is a technique of rapidly growing importance. Gas chromatography/matrix-isolation/Fourier transform infrared spectroscopy (GC/MI/FTIR) freezes the GC effluent in an argon matrix. This allows for the FTIR analysis of each component of a complex mixture to be performed with the high sensitivity and specificity of matrix-FTIR detection. The GC/MI/ FTIR technique has sensitivity 100 times greater than the light-pipe GC/IR method and the specificity to distinguish between isomers that are difficult to distinguish by GC/MS. In this paper, application of GC/MI/FTIR to the analysis of fossil fuels is described. Infrared spectra of matrix-isolated fossil fuel components is presented, and the utility of GC/MI/FTIR is discussed.

### 0240 Storage

*REFER ALSO TO CITATION(S) 19986*

### 0250 Combustion

19990 **(PB—87-121257/XAB) Sulfur emissions from combustion of residual fuel oil based on EEC energy demand and supply, 1980-2000.** Ellis, R.J.; Arguile, R.; Bocca, P.L.; Campobasso, A.; Cerase, A. (Concawe, The Hague (Netherlands)). 1986. 47p. (CONCAWE—5/86). NTIS, PC PC E03/MF E01.

An assessment was made of the energy consumption and oil-combustion-related sulfur emissions in the period 1980-2000 for the EEC-10 countries. The possibility of further sulfur emissions reduction and its effects on cost and refining infrastructure are discussed.

## 03 NATURAL GAS

### 0302 Geology And Exploration

*REFER ALSO TO CITATION(S) 19965, 21272, 21280*

19991 **(DOE/METC—86/4069) Hydrate resource assessment of the North Slope of Alaska: Technical note.** Mroz, T.H. (USDOE Morgantown Energy Technology Center, WV). May 1985. 46p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86006594.

This study was initiated to assess the gas hydrate potential of Alaska's North Slope. All current data for wells existing between depths of 300 and 5000 feet in the Petroleum Information, Inc., North Slope Well File (NSWF) were used; 96 wells of the 668 wells in the NSWF fit this requirement. The data included gamma ray, SP, resistivity, sonic, caliper, and temperature logs; lithological sections and drill core analyses that were correlated to seismic sections; sand shale ratio maps; and permafrost structure and hydrocarbon source-rock analyses. The areas identified as containing possible hydrate deposits are Point Barrow, Kuparuk River, Prudhoe Bay Field, Cape Simpson, and Cape Thompson. Based on the work completed to determine the gas potential in-place and based on the geology and reservoir characteristics of the rocks in the hydrate stability zone (HSZ), it is estimated that a significant volume of gas hydrates may exist in the Tertiary-age Saganvanirktok Formation, and the Cretaceous-age Colville and Nanushuk groups. 7 refs., 16 figs.

### 0303 Drilling, Production, And Processing

*REFER ALSO TO CITATION(S) 19975*

19992 **(PB—87-144366/XAB) Tight-gas sands evaluation and technology development. Final report, May 1982-July 1986.** (CER Corp., Las Vegas, NV (USA)). 1986. 115p. NTIS, PC A06/MF A01.

See also report dated Mar 83, PB83-242305.

The overall objectives of the work performed are to: Assist GRI's management in planning and implementing a research program for evaluating and developing technology in tight gas sands; Provide such a Tight Gas Sands Program with technical and administrative support services; Coordinate and supervise acquisition of pertinent tight gas sands information and field data; Transfer technological advancements developed in the program to the oil and gas industry. The report summarizes the CER activities and accomplishments achieved in the course of performing the tasks.

### 0304 Products And By-products

*REFER ALSO TO CITATION(S) 20166*

### 0306 Marketing And Economics

19993 **(DOE/EIA—0130(86/12)) Natural Gas Monthly, December 1986.** (USDOE Energy Information Administration, Washington, DC. Office of Oil and Gas). 26 Feb 1987. 157p. NTIS, PC A08 - GPO. File Number DE87006417.

Current data on natural and supplemental gas consumption, disposition, production, prices, storage, imports, and exports in the United States are provided for each year from 1980 through 1986 with monthly data for the most recent 3 years. Some data are also given by State or city; some data are also given for previous years. Operating and financial data for major interstate natural gas pipeline companies, as well as data on filings, ceiling prices, and transportation under the Natural Gas Policy Act of 1978, are also included. Explanatory notes, a discussion of data sources, and a glossary are included. Three reports previously published as separate annuals are now published in this report. The three are: "Underground Natural Gas Storage in the United States" (DOE/EIA-0239). "US Imports and Exports of Natural Gas (DOE/EIA-0188), and "Main Line Sales of Natural Gas to Industrial Users" (DOE/EIA-0129). 6 figs., 34 tabs.

### 0309 Artificial Stimulation

*REFER ALSO TO CITATION(S) 19971*

### 0330 Properties

*REFER ALSO TO CITATION(S) 19989*

### 0340 Combustion

*REFER ALSO TO CITATION(S) 20510*

## 04 OIL SHALES AND TAR SANDS

*REFER ALSO TO CITATION(S) 21623*

19994 (DOE/METC—86/6045, pp 1-3) **Opening Remarks.** Bechtel, T.F. Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—).

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

The current state of oil prices and their effects on oil shale research in industry are discussed. Some technical issues in oil shale research are outlined and future directions suggested. Overall the

author stresses that economic factors drive the oil shale program and must be given serious consideration.

19995 (DOE/METC—87/6073, pp 1-10) **Tar sands - the opportunity.** Rendall, J.S. (Solv-Ex Corp., Albuquerque, NM). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

Tar Sands - The Opportunity describes the role of this industry and its place in their society's energy future. The development of this resource on a modular basis with the use of Solv-Ex technology is described. The role of the Government is also discussed with the kind of incentives needed to encourage development.

## 0401 Reserves And Exploration

*REFER ALSO TO CITATION(S) 19998*

19996 (DOE/METC—87/6073, pp 11-19) **AOSTRA/Arc joint oil sands geology program: regional resource studies of the Alberta oil sands deposits.** Harrison, R.S. (Alberta Geological Survey, Edmonton). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

Since 1979 the Alberta Oil Sands Technology and Research Authority and the Alberta Research Council have jointly funded a major oil sands mapping and research program by the Alberta Geological Survey, a department within the latter agency. This program has focussed on both the well known Cretaceous deposits (Peace River, Wabasca, Athabasca, and Cold Lake) and on the relatively little-studied, bitumen-bearing Devonian and Mississippian limestones and dolomites which underlie the Cretaceous sands. It has been suggested that these Paleozoic carbonates may contain bitumen in amounts comparable to, or in excess of, the combined reserves of the overlying Cretaceous deposits. In addition to the more traditional data gathered as part of the regional mapping program, log-based parameters, ground-truthed where possible against core and core analyses, permit the generation of a suite of resource characterization maps. These maps document features such as cumulative and uninterrupted clean sand, water bearing heat-thief zones, permeability barriers, and bitumen distribution at specified saturation values. Supplementing the documentation of these resource characteristics is the development of predictive depositional models and, on a finer scale, detailing of reservoir mineralogy and pore fabric. Understanding the nature and controls on the reservoir character, through scales ranging from the regional to the microscopic, has enhanced the capability for effective resource assessment and exploitation. Insight gained applies not only to the deposits as a whole, but also to many aspects of in-situ thermal recovery operations, particularly with respect to operational siting, strategy, and evaluation. 21 references.

## 0402 Site Geology And Hydrology

*REFER ALSO TO CITATION(S) 19996*

19997 (DOE/METC—87/6073, pp 20-45) **Resource characterization of the Clearwater Formation, Cold Lake oil sands deposit, east central Alberta.** Wightman, D.M.; Berezniuk, T. (Alberta Geological Survey, Edmonton). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The Clearwater Formation is part of the Lower Cretaceous Mannville Group which contains much of Alberta's heavy oil and bitumen reserves. The bitumen resource, which lies at in situ recovery depths, has been outlined from Townships 60 to 66, Ranges 1 to 10W4 and Townships 67 to 68, Ranges 1 to 5W4 using four wells/Township. Stratigraphic picks were made for the Clearwater and McMurray formations as well as for the sub-Cretaceous unconformity surface. Cut-offs on the gamma ray log defined four basic rock types: sand, argillaceous sand, sandy shale and shale. Core analyses were correlated to electric logs to establish resistivity cut-offs for one, six and ten weight percent bitumen. The topography on the sub-Cretaceous unconformity affected deposition of the Clearwater and directly controlled sedimentation during McMurray time. The Clearwater Formation is fairly constant in thickness (35 to 45 m) over most of the study area but increases from 45 to 65 m in Townships 64 to 66, Ranges 1 to 4W4. This same area contains the thickest (15 to 45 m) oil sands with greater than six weight percent bitumen. Values throughout the remainder of the deposit are predominantly 5 to 15 m. The oil sands are underlain by water sands except for a small area in the north-central part of the deposit. The Clearwater Formation was deposited in a marine delta that advanced northwards into the boreal sea. Reservoir quality is determined by structure (which controls bottom water) and position within the deltaic complex (which controls sand quality and thickness). Thus, both structure maps and an accurate depositional model must be used to guide future exploration and development. 6 references, 21 figures.

19998 (DOE/METC—87/6073, pp 46-50) **Structural and stratigraphic controls Uinta Basin tar sand deposits, northeast Utah.** Ritzma, H.R. Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The Uinta Basin, northeast Utah, contains 26 tar sand deposits grouped in three geographic areas and distinct geologic settings. Five structural episodes superimposed successively over a span of about 230 million years (since early Triassic) and interrelated depositional patterns have profoundly affected the location, size and configuration of these deposits and the bitumen (oil or tar) contained in them. Location and configuration of six deposits are controlled by the Towanta Lineament, a deep-seated fracture system of regional extent. The basin's south flank is characterized by simple structure, low dip and minor faulting. Stratigraphy of the host sedimentary formations is of prime importance. About 90% of the Unita Basin tar sand resource is located here. The contrasting structural pattern and history of the basin flanks has profoundly affected character of oil and configuration of deposits. Factors such as original environment of deposition, depth of burial, geothermal gradient, overburden pressure, and introduction of meteoric water are highly significant. Almost all oil contained in the deposits originated in the fluvial and lacustrine Wasatch and Green River formations (Paleocene-Eocene). Oil is paraffinic, between 40 and 14.50 gravity (api), and averages about 0.45% sulfur. The resource is estimated to total 13.6 billion barrels of oil in measured, estimated and inferred/speculative categories. Most (97%+) is in four giant deposits and one large deposit: Asphalt Ridge, 1.1 billion bbls.; Hill Creek, 1.1 billion bbls.; P.R. Spring, 4.4 billion bbls.; Sunnyside, 6.5 billion bbls.; and Whiterocks, 120 million bbls. These deposits, excepting Hill Creek, are considered to contain most of the economically recoverable resource in the basin. 3 figures, 1 table. 3 figures, 1 table.

19999 (DOE/METC—87/6073, pp 51-58) **Petrologic aspects of some bitumen-bearing sandstones from Sunnyside, Utah.** Schenk, C.J.; Pollastro, R.M. (Geological Survey, Denver, CO). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

Sandstones from the bitumen deposit near Sunnyside, Utah, exhibit many diagenetic modifications that should be considered in any attempt to recover the bitumen. The sandstones generally are subfeldspathic to feldspathic arenites, with various amounts of carbonate lithic fragments. Detrital feldspars have been partially dissolved to partially cemented by overgrowths, whereas many quartz grains have developed syntaxial overgrowths. Many minerals, including quartz, feldspar, illite, mixed-layer illite/smectite, chlorite, kaolinite, zeolites (largely analcime), calcite, dolomite, siderite, and ankerite, are cements in the sandstones. The amount of any one cement varies considerably from sample to sample. Some minerals, such as dolomite and kaolinite, also replace the detrital grains: dolomite replaces detrital quartz and feldspar, and kaolinite commonly replaces feldspars and carbonate clasts. All of these authigenic minerals serve to reduce permeability and porosity and increase the

surface area of the grains facing the pores, and will have a deleterious effect on recovery attempts. 14 references, 9 figures.

20000 (DOE/METC—87/6073, pp 59-89) **Geology of the syncrude oil sand leases.** Tammam, A.O.; Wach, G.D.; Stewart, G.A. (Syncrude Canada Ltd., Edmonton, Alberta). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The McMurray Formation sediments were deposited unconformably in a broad drainage basin developed on an eroded argillaceous limestone surface of Devonian age. The basin was bounded by the Devonian Grosmont ridge to the west and the Precambrian Shield to the east. This basin was progressively filled with clastic sediments in a series of transgressive-regressive sequences in an overall transgressive sequence. The characteristics of lithology, bedforms and stratigraphic position of the various sedimentary bodies, and the analogies with recent and ancient depositional environments suggest that the McMurray Formation within the Syncrude leases changed from a continental, fluvial channel and floodplain environment, in the Lower Member, to an estuarine tidal flat and tidal channel system, in the Middle Member, to nearshore and open marine environments, in the Upper Member. The interpretation and correlation of core description, bitumen analysis and geophysical log data from over 2000 boreholes drilled on the Syncrude leases, combined with regional outcrop and borehole studies, enabled geologists to map the lateral and vertical distribution of the McMurray Formation sedimentary facies. The conventional maps and sections were not adequate to portray detailed facies distribution. Computer programs were developed to annotate facies data on a suite of slice maps at 4 meter intervals below the top of the Wabiskaw Member of the Clearwater Formation. This method proved effective for mapping facies distribution. 15 references, 44 figures.

20001 (DOE/METC—87/6073, pp 90-111) **Major tar sand deposits of Utah, United States: recent field investigations.** Oliver, R.L.; Sinks, D.J. (Western Research Institute, Laramie, WY). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—). Contract AC07-76ET10723.

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The results of field investigations at three major Utah tar sand deposits are presented along with representative core sections. A resource evaluation of the PR Spring deposit in the southeastern Uinta Basin includes stratigraphic cross sections and isopleth maps of significant reservoir engineering properties for the bitumen-bearing units. Resource and site selection criteria are presented. Areas of greatest potential for in situ combustion processing are identified. Adverse and favorable geologic resource characteristics which affected in situ combustion processing and steamflooding at the Northwest Asphalt Ridge deposit, northeastern Uinta Basin, are described. This study led to a better understanding of the structural and lithologic influences on in situ thermal processing. Stratigraphic correlations and a fence diagram constructed from core data from the Tar Sand Triangle deposit, southeastern Utah, are illustrated. The total resource estimate is calculated to be 6.3 billion barrels of oil in place, making the Tar Sand Triangle apparently the single largest tar sand deposit in the US. 17 figures.

## 0403 Drilling, Fracturing, And Mining

20002 (DOE/METC—87/6073, pp 112-131) **Review of horizontal well technology.** Joshi, S.D. (Phillips Petroleum Co., Bartlesville, OK). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

This paper is a review of the state of the art of horizontal well technology for producing heavy oils and tar sands. The review includes a discussion of reservoir engineering, drilling, and completion aspects of horizontal well technology. The available field data are also discussed. The review is restricted to the steam-horizontal well combination technology. The available data demonstrate that for tar sand oil recovery, steam assisted gravity drainage using horizontal wells is an efficient oil production mechanism. For heavy oil recovery, steam assisted gravity drainage as well as steam drive employed with horizontal wells seem to give substantially higher recovery that that obtained using vertical wells. In addition, in mature steam drives with significant steam override, horizontal wells could be used to reduce gravity segregation and produce oil from the bottom layers. 58 references, 9 figures, 3 tables.

20003 (DOE/METC—87/6073, pp 132-135) **Status of an oil mining project.** Trent, R. (New Tech Oil Co., Kaycee, WY). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The North Tisdale project, located near Kaycee, Wyoming, is operated by the New Tech Oil Company which was formed six years ago to develop oil mining technology. A history of the field and the geology of the area is briefly summarized. The well drilling techniques and the performance of the drilling equipment are described. The project is testing two concepts: a decline combined with drainage wells and a mine shaft with horizontal drainage wells. Drilling costs are projected to be 15 cents per foot. A patented method for separation of oil, water, and gas in the well bore is also briefly described.

20004 **Fracture of brittle rock under dynamic loading conditions.** Chen, E.P.; Taylor, L.M. (Sandia National Labs., Albuquerque, NM). pp 175-186 of Fracture of mechanics of ceramics. Vol. 7. Bradt, R.C.; Evans, A.G.; Hasselman, D.P.; Lange, F.F. New York, NY; Plenum Press (1986). (CONF-8506128—).

From 4. international symposium on the fracture mechanics of ceramics; Blacksburg, VA, USA (18 Jun 1985).

A continuum damage model is used to study the dynamic fracture of rock in this investigation. In this model, damage in rock is considered to be the fraction of rock volume that has been tension relieved; and, tensile microcracking has been taken as the damage mechanism. In compression, the rock responds in an elastic/perfectly plastic manner. The model includes the strain-rate effect explicitly. Two example applications involving concrete cracking and oil shale blasting are presented to demonstrate the utility of the damage model.

## 0404 Oil Production, Recovery, And Refining

*REFER ALSO TO CITATION(S) 19902, 20001, 20002, 20026, 20030, 20031, 20036, 21278*

20005 (DOE/METC—86/6045, pp 5-9) **METC oil shale project: summary of systems analysis and data base activities.** Burchfield, J.E. Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—).

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

The oil shale project at the Morgantown Energy Technology Center (METC) is described and the four major activities of the project portion are summarized. These are: systems analysis, data base management, research, and modeling. The use of ASPEN, Advanced Systems for Process Engineering, is described in some detail. An ASPEN based model of fluidized-bed retorting has been developed.

20006 (DOE/METC—86/6045, pp 10-15) **Laboratory high-heating-rate studies of pyrolysis and retorting of oil shale.** Kovach, J.J. Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—).

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

As part of the Department of Energy's (DOE) Oil Shale Program, Morgantown Energy Technology Center (METC) in-house activities are aimed at investigating the pyrolysis mechanisms of oil shale retorting at high heating rates. The METC oil shale retorting at high heating rates. The METC oil shale research encompasses laboratory experiments on rapid pyrolysis of shales, support-

ed by mechanistic, kinetic modeling efforts. The laboratory experiments are focused on the thermal decomposition of the organic material at two stages: during the formation of primary products and during the secondary reactions of those products. Experimental systems have been designed to evaluate these processes independently. Resulting information from the laboratory studies also will be utilized to advance understanding of pollutant precursors and their distribution and speciation in the products and by-products. Mechanistic models are being developed in parallel with the experimental studies in order to describe on a fundamental level the chemical reaction, mass, heat, momentum transport processes, and gas stream physics. Laboratory experimental approaches and modeling studies are described and the in-house activities discussed herein.

20007 (DOE/METC—86/6045, pp 16-21) **Western Research Institute oil shale project summary.** Sudduth, B.C.; Dorrence, S.M.; Coomes, R.M.; Cha, C.Y.; Vawter, R.G.; Smith, E.B.; Sullivan, P.J.; Barker, F.P.; Roberston, R.E.; Miknis, F.P. (Western Research Institute, Laramie, WY). Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—). Contract FC21-83FE60177.

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

The primary objectives of the present work are (10 to provide a basic understanding of the reaction chemistry and transport processes in oil shale retorting systems, (2) to define the fundamental characteristics of oil shales selected by DOE for research conducted within the Oil Shale Program, (3) to provide information on retorting processes and how to control them over the range of operating conditions, and (4) to identify and quantify materials of environmental concern in solid, liquid, and gas by-products from oil shale conversion processes. These objectives are in accordance with the DOE program goal to develop a reliable predictive capability for the efficient, economic and environmentally acceptable conversion of oil shale to useful liquid products through a thorough understanding of the chemical and physical phenomena involved in the conversion processes. Research investigations under this cooperative agreement have been identified each year to address key elements in the Oil Shale Program. Investigations are currently being carried out in the following research activities: chemical and physical properties, in situ processes, and novel concepts.

20008 (DOE/METC—86/6045, pp 32-43) **In situ processes.** Fahy, L.J.; Merriam, N.W.; Vawter, R.G.; Cha, C.Y.; Sudduth, B.C. Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—). Contract FC21-83FE60177.

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

In situ processing research at the Western Research Institute (WRI) is developing solutions to problems that have been encountered in previous field retorting tests. Laboratory experiments are providing correlations for predicting oil shale compaction in commercial modified in situ retorts. Horizontal retorting tests at low void volumes are evaluating in situ technology applications to the New Albany shale resource in Indiana. Retorting tests in nonuniform ruble beds are developing operating methods for improving retorting sweep efficiencies and reducing oil combustion losses.

20009 (DOE/METC—86/6045, pp 78-109) **Lawrence Livermore Laboratory oil shale project.** Lewis, A. (Lawrence Livermore National Lab., NM). Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—). Contract W-7405-ENG-48.

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

The LLNL project combines laboratory and pilot-scale experimental measurements with mathematical modeling of fundamental chemistry and physics to provide a technical base for evaluation of oil shale retorting alternatives. Mathematical modeling of the chemical and physical processes involved in oil shale retorting is a key component of our oil shale project. The author models encompass three levels of complexity: individual chemical reaction modeling, multireaction particle models, and overall retort models. One of the most useful general products of our modeling work is the distillation of data and theories into a compact and usable form.

20010 (DOE/METC—86/6045, pp 110-121) **Comparison of processing parameters for generic in situ and surface processes.** Hommert, P.J. (Sandia National Labs., Albuquerque, NM). Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—). Contract AC04-76DP00789.

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

A simple model for the in situ retort process has been constructed that can be used to estimate process related variables. Comparison studies made using this model indicate that first generation in situ technology performs significantly below optimal surface processing. These studies indicate that the use of steam in the inlet stream greatly increases the power consumption and water requirements of an in situ retorting system. Second generation technology that involves uniform processing offers the promise of significant improvements in the performance of in situ retorting making this technology comparable in process efficiency to surface processing for leaner shales.

20011 (DOE/METC—86/6045, pp 122-132) **Demonstration of uniform retorting of oil shales beds with void contrasts.** Bickel, T.C. (Sandia National Labs., Albuquerque, NM). Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—). Contract AC04-76DP00789.

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

A different approach to the retort blast design in which increased void at the retort perimeter is offset by varying the particle size is investigated. This work is aimed at increasing the local yield in large commercial-size retorts to that achieved in one-dimensional, laboratory-scale experiments. To provide data for the development of these processes we have performed laboratory experiments in which highly-instrumented, adiabatic, 100 kg beds of shale were retorted. The experiments include uniform (isotropic) beds of shale as well as rubble beds with zones of differing particles size and void normal to the direction of flow (anisotropic). the latest in this series (Retort L-46) was designed using data from extensive pressure drop experiments on oil shale rubble beds (Bickel, Cook, and Engler, 1986). Retort L-46 was performed to verify on the laboratory-scale that uniform retorting fronts could be achieved in anisotropic beds of shale. Current efforts are directed at developing a small-scale explosive technique to provide low-void rubble for the 100 kg retort.

20012 (DOE/METC—86/6045, pp 133-144) **Status of fragmentation modeling development.** Gorham-Bergeron, E.D.; Kuszmaul, J.S. Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—). Contract AC04-76DP00789.

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

The objective of the fragmentation modeling program is to develop the ability to predict rubble characteristics (fragment sizes and void distribution) that will be induced by a given blasting design. This predictive ability will aid in the development of blasting designs for in-situ retorting of oil shale. A finite-element code is used to model the explosive detonation and fracturing of the early-time problem. This code uses one material model for the explosive and another for the rock. The explosive model uses the JWL (Jones-Wilkins-Lee) equation of state to describe the pressure within the gaseous products as they expand the walls of the borehole (Dobratz, 1981). The constitutive model for the rock describes the accumulation of damage that occurs as the rock describes the accumulation of damage that occurs as the rock fractures under tensile loads supplied by the passing shock and release waves (Taylor, et al, 1986). The later-time problem starts with a collection of fragments and uses a distinct-element code to model the motion. The code used for this problem, CAROM (for CAlculated ROck Motion), is event driven and is therefore unconditionally stable (E.D. Gorham-Bergeron, 1985).

20013 (DOE/METC—86/6045, pp 199-207) **Radio frequency retorting in the low void retort.** Cha, C.Y.; Moore, D.F.; Merriam, N.W.; Saxena, V.K. (Western Research Institute, Laramie, WY). Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—). Contract FC21-83FE60177.

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

During the past year, the authors have completed the construction of the RF energy system and modifications to the low void retorting system to conduct RF retorting tests. Delay in delivery of the RF generator, approximately one year, has resulted in the delay of the test schedule. The first RF test was conducted in July 1986 for 48 hours duration at a RF power level of 1500 watts only due to practical limitations of the RF generator. Preliminary results show some retorting.

20014 (DOE/METC—87/6073, pp 251-269) **Advanced thermal EOR technology.** Ware, C.H.; Amundson, R.M. (World energy Systems, Rocky Mount, VA). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

Simple laboratory tests simulating in situ hydrogenation of oil-in-place produce significant permanent improvements in oil quality, resulting in more readily producible and more valuable oil. Typical improvements of 200-fold viscosity reduction, 8°API gravity increase, and 20% sulfur reduction have been achieved with samples from eight sites in the US and Canada using conditions which can be created in a reservoir. The samples of tar sand bitumens from Utah, Texas, and Alberta show the most dramatic improvements including viscosity reductions of up to 10,000:1. The hardware for injecting superheated steam and hydrogen to create in situ hydrogenation conditions is under development and all experiments are conducted with a proprietary computer control system. Reservoir engineering studies have shown that recoveries of 40-60% can be expected. These combined with higher production rates lead to economics which show that the technology begins to be profitable at heavy oil prices of less than $20.00/bbl. By mid-1986, ten US patents will have been obtained which describe the downhole hardware, in situ hydrogenation, and the recovery process. Another is pending. They are negotiating with several companies to join in the completion of the development and undertake a field trial. 4 references, 7 figures, 6 tables.

20015 (DOE/METC—87/6073, pp 270-283) **Comparison of the effect of thermal cracking and low temperature oxidation on fuel deposition during in situ combustion.** Moore, R.G.; Bennion, D.W.; Millour, J.P.; Ursenbach, M.G.; Gie, D.N. (Univ. of Calgary, Alberta). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

Thermal cracking and low temperature oxidation reactions cause the deposition of fuel during in situ combustion. Experimental data, in which the liquid phase compositions are measured in terms of the pseudo components coke, asphaltenes and maltenes, are presented for both thermal cracking and low temperature oxidation of Athabasca bitumen. The data show that significant compositional changes resulting from low temperature oxidation occur at low temperatures and short times while significantly higher temperatures and longer times are required to achieve the same results through thermal cracking. Simple models describing the thermal cracking and low temperature oxidation product yields are presented to highlight the similarity between the two mechanisms. Aspects of the thermal cracking and low temperature oxidation kinetics which are discussed include the influence of water on the thermal cracking product yields and the similarity of product yields for low temperature oxidation reactions when they occur in the absence or presence of core and water. Comments are made on the high cumulative oxygen uptakes observed under low temperature (250 C) conditions. The results show that low temperature oxidation reactions should be considered when designing in situ combustion ignition procedures. 28 references, 2 figures, 5 tables.

20016 (DOE/METC—87/6073, pp 284-295) **Laboratory studies of forward combustion in tar sand (Tar Sand Triangle).** Romanowski, L.J. Jr.; Thomas, K.P. (Western Research Institute, Laramie, WY). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—). Contract FC21-83FE60177.

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

Bench-scale experiments were conducted on tar sand in a tubular reactor to evaluate the forward combustion process. The purpose of the study was to evaluate the effect of injected air flux on the oil yield, product oil quality, and process efficiency. Air injection fluxes ranged from 16 to 111 scfh/ft$^2$. One test was also conducted using steam dilution of the injected air. 10 references, 4 figures, 4 tables.

20017 (DOE/METC—87/6073, pp 296-304) **Comparison of laboratory and field steamfloods in tar sand.** Johnson, L.A. Jr.; Thomas, K.P. (Western Research Institute, Laramie, WY). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—). Contract FC21-83FE60177.

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

In situ recovery technologies for tar sand and heavy oil are simulated at the Western Research Institute to prepare for pilot tests and commercial operations. Wide ranges of process parameters are tested in one-dimensional reactor tubes in which the tar sand or heavy oil is uniformly reconstituted to nearly the same permeability and porosity as the field resource. Three-dimensional process performance is verified in a reactor system that demonstrates the most promising operating parameters in consolidated blocks of the field resource. Both of these reactors are capable of testing combustion or steamflood processes at pressures as high as 1000 psi. Initial laboratory simulation have tested steamflooding of Asphalt Ridge tar sand for comparison with previous results from a pilot test near Vernal, Utah. Oil production rates, properties and residual saturations have been measured for different operating conditions, reservoir properties and bitumen concentrations. Corresponding operating parameters and production performance are compared to evaluate the relationships between the laboratory simulations and the field test results. These comparisons show that the residual oil saturations and sweep efficiencies in the laboratory tests are similar to the results of the field tests. 9 references, 3 figures, 4 tables.

20018 (DOE/METC—87/6073, pp 305-317) **Mathematical modeling for in situ thermal recovery processes in tar sand: model description and verification.** Vaughn, P. (Western Research Institute, Laramie, WY). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—). Contract FC21-83FE60177.

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

A fundamental model for numerically simulating the in situ thermal recovery of oil from a tar sand resource has been developed. This simulator generates results consistent with experimental findings. The numerical model accounts for the major phenomena that occur in the thermal processing of tar sand. The model accounts for the three-phase flow of oil, water, and gas. Mass transfer among the phases and components is dictated by liquid and vapor equilibria, reaction kinetics, reservoir properties, and processing conditions. Energy is transferred by the mechanisms of conduction, convection, reaction kinetics, and by vaporization and condensation. The solution technique employed in the model is based on a highly efficient method using the Newton-Raphson iteration scheme with a variable time-step algorithm. Results are compared with results of another numerical simulator as well as with results from a recent experiment conducted at WRI. These initial comparisons have shown good agreement and have identified areas for further improvement. 6 references, 1 figure, 2 tables.

20019 (DOE/METC—87/6073, pp 318-323) **Acoustic emissions for the determination of production front locations in tar sand.** Warriner, J.B. (Army Engineer Waterways Experiment Station, Vicksburg, MS). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—). Contract AI01-85FE60731.

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The objective is to be able to deploy acoustic sensors above an in situ deposit and use the received signals to tritition of AE will occur on the active EOR fronts. Laboratory tasks include a variety of rock mechanics tests during which AE are recorded and analyzed for frequency content and amplitude. The purpose is to attempt to characterize the mode of strain deformation (shear, extension, grain fracture, etc.) in terms of the acoustic output. A second laboratory task is devoted to thermal effects on AE, i.e., decrease velocity and amplitude together with increases in attenuative loss with heat. Domestic US tar sands are used exclusively in laboratory testing. Field application of AE technology includes the tasks of sensor selection, sensor placement strategy, and system development for data acquisition, analysis computation, and near-real-time display of the interpretations. Thus far, sensor placement strategy includes a requirement for down-hole geophones within the tar sand stratum. Investigation is proceeding to use existing well casings as wave guides conducting AE from in situ to the surface to minimize the requirement for expensive down-hole phones. Location computer software presently uses least-squares algorithms to produce location results from time-of-arrival data. A concept called beam-forming is being investigated as an alternative to current algorithms. Signal extraction from inherently noisy data is also being examined in detail. The tentative primary field location for acquiring data and developing methodology in Gregoire Lake In Situ Pilot in Alberta, Canada. 6 references.

20020 (DOE/METC—87/6073, pp 419-430) **Processing and development of Alabama tar sands.** Misra, M. (Univ. of Alabama, University). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

Separation of bitumen from Alabama tar sand deposits can be accomplished by size reduction and froth flotation. Under appropriate experimental conditions more than 80% bitumen can be recovered in a concentrate containing as much as 25 weight percent bitumen from a feed material having 6 to 8 weight percent bitumen. The efficiency of bitumen recovery depends on the extent of size reduction, viscosity of the bitumen phase and the nature of the sand/bitumen association. Rejection of more than 65 weight percent barren tailings and ease of water removal make such a process strategy both energy and cost effective for lean tar sand deposits. Settling rate of tailings sand in a low alkaline environment is fast and more than 80% of the process water can be recycled without any deleterious effect on the separation efficiency. Further upgrading of the beneficiated concentrate can be accomplished by a dilution-centrifugation technique. Under optimum conditions the diluted bitumen contains less than 0.5 weight percent fine sand. In addition, thermal pyrolysis has been tested to process the bitumen enriched concentrate and preliminary results are presented. 27 references, 9 figures, 4 tables.

20021 (DOE/METC—87/6073, pp 431-436) **RTR DAP process for oil recovery from tar sands.** Porcari, G.; Dente, M.; Falcon, J.A.; Sogaro, A. (RTR, Lugano, Switzerland). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

DAP is a diluent assisted extraction process which was conceived by RTR in 1980. The process concept is based on the reduction of both viscosity and specific gravity of the bitumen prior to its separation from the mineral. The water utilized in the process is clarified and completely recycled. The tailings from the process are in a solid form and can be disposed of at an early stage in the mined out area of the plant site. The process has been successfully tested in a continuous pilot plant with tar sands from different areas of North America and from Madagascar. A large scale batch process simulator has been built and operated to obtain process and engineering data for equipment scale up. The capital and operating costs for a typical extraction plant is presented. 1 figure, 2 tables.

20022 (DOE/METC—87/6073, pp 437-453) **Demonstration plant design and economics of the Beaver-Herter extraction process.** Daniel, R.D.; Babcock, R.E. (Diversified Petroleum Recovery, Inc., Little Rock, AR). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The Herter process is a surface-mined solvent extraction process which utilizes fatty acids as the solvent. The uniqueness of the Herter process is that it provides a low energy method of separating the fatty acids from the recovered oil for subsequent recycling. The Herter process recovers the fatty acid by saponification, followed by migration of the soap to the aqueous phase, and then desaponificaiton of the resulting soap phase again followed by phase separation. The Beaver-Herter process is a modified in which short-chain alcohol is added to optimize the separation of fatty acids. Extraction efficiencies 85-90% can be achieved in a single stage contactor. Recovery efficiencies greater than 95% can be achieved in multistage contacting in which enhanced sand/bitumen separation techniques are used. This paper presents a preliminary economic and design analysis of a 700 ton/day (400 bbl/day) demonstration plant under consideration for construction on a southern Oklahoma site. The model developed is relatively sophisticated yielding process stream flows and allowing economic sensitivity analysis with respect to a large number of site specific input parameters including bitumen ratio, bitumen value, mining costs, crushing costs, process chemical costs, tax structure, and utility costs. Conclusions of the analysis indicate that the Beaver-Herter process is an economically viable process that is more than competitive with other solvent extraction processes. 10 references, 6 figures, 6 tables.

20023 (DOE/METC—87/6073, pp 454-467) **Upgrading Cold Lake bitumen using the HSC-ROSE process.** Sprague, S.B.; Ishibashi, M.; Washimi, K. (Kerr-McGee Corp., Oklahoma City, OK). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

Upgrading is a key step in utilizing tar sand bitumen. While a variety of processes are commercially available, the HSC-ROSE process, a combination of Toyo/Mitsui's High Conversion Soaker Cracker (HSC) and Kerr-McGee's ROSE supercritical fluid technology, gives a higher liquid yield than other upgrading processes. This report presents preliminary pilot-plant data obtained from processing vacuum-reduced Cold Lake bitumen in the HSC-ROSE process. Product testing and utilization, the subjects of a subsequent paper, are briefly discussed here. The work presented in this paper was done by Toyo Engineering Corp., Mitsui Coke Co. and Kerr-McGee Corp. in their respective HSC and ROSE pilot-plants. The vacuum-reduced bitumen was processed in the HSC pilot plant, then the HSC residue was processed in the ROSE pilot-plant. To show the flexibility of the process combination, the HSC pilot-plant was operated at two conversion levels, and the ROSE pilot-plant was operated at two extraction levels. One of the goals of this project was to produce a syncrude that could be easily transported to and processed in a refinery. The HSC-ROSE process could produce a syncrude composed of the virgin distillates, HSC distillates and ROSE deasphalted oil (DAO). The residue from the HSC-ROSE process can be used as fuel, and combustion tests are being conducted as part of the project. The inherent flexibility of the HSC-ROSE process makes it possible to tailor its operation for either a field or central upgrading unit. 3 references, 3 figures, 12 tables.

20024 (DOE/METC—87/6073, pp 468-484) **VEBA-Combi-Cracking (VCC), a proven technology for high conversion of heavy bottoms.** Wensel, F.W.; Grawser, U.; Niemann, K. (VEBA OEL, Gelsenkirchen-Hassel, West Germany). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

A brief introduction into the VCC technology itself, the achievable conversion rates, syncrude qualities, process flexibility and the usage of the remaining hydrogenation residue with special emphasis on environmental impact is given. The actual commercial status based on past commercial experience, process improvements in PDU and Pilot Plants as well as the experience gained in the operation of a semi-commercial plant is described in some detail. The first commercial application of residue conversion and the basis for large size plants are illustrated. 27 figures.

20025 (DOE/METC—87/6073, pp 502-507) **Competing reactions during hydropyrolysis upgrading of tar sand bitumen and residual materials.** Bunger, J.W.; Tsai, C.; Russell, C.P. (Univ. of Utah, Salt Lake City). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

Hydropyrolysis has been shown to involve several major, competing reactions. These include cracking of paraffins and naphthenes, hydrogenation of olefins and polycondensed aromatics, dehydrogenation of naphthenes, and hydrogenolysis of s-bonded heteroatoms. A model compound system consisting of n-decane (60 C%), methyl cyclopentane (30 C%) and 1 methylnaphthlene (10 C%) was hydropyrolyzed at temperatures ranging from 510-540 C and residence times from 15-50 sec. The relative reaction rates for all but the hydrogenolysis reaction could be determined from the data. Rates of reaction relative to cracking of n-decane at 510 C were: cracking of naphthenes (1.0), dealkylation (3.6), hydrogenation of aromatics (0.1), dehydrogenation of naphthenes (4.5). At 540 C the relative rates were 0.5, 2.4, 0.14 and 1.8, respectively. This data shows that increasing temperature results in a relative increase in hydrogenation and preservation of naphthenes compared to the cracking and dealkylation reactions. This information, if shown to hold true for complex mixtures, will be highly useful for reaction engineering in hydropyrolysis development.

## 0405 Properties And Composition

*REFER ALSO TO CITATION(S) 19972, 19988, 19989, 20007, 20016*

20026 (DOE/METC—86/6045, pp 22-31) **Physical and chemical properties of oil shales.** Miknis, F.P.; Branthaver, J.F.; Chong, S.L.; Ensley, E.K.; Guffey, F.D.; Holmes, S.A.; Johnson, L.S.; Mason, G.M.; Netzel, D.A.; Robertson, R.E.; Turner, T.F. Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—). Contract FC21-83FE60177.

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

During the past year, WRI (as one program participant) has been intensively studying two interim reference oil shales. One is from the Mahogany Zone, Green River Formation, Anvil Points, Colorado mine. The second is a New Albany oil shale from the Clegg Creek Member, Bullitt County, Kentucky. Fundamental properties of the oil shale ores are being determined. Oil yield, thermal properties of the oil shale ores are being determined. Oil yield, thermal properties, mineralogy, carbon content and character, and kinetics of prepared from the ores and the concentrates were characterized. Interim reference shale oils were characterized and physical property data were calculated. Oil yield losses due to coking were examined. In the environmental area, mass balance Fischer assays have been completed on the ores and the distributions of carbon, hydrogen, nitrogen, sulfur, and trace elements into spent shale, shale oil, product water and product gas have been determined.

20027 (DOE/METC—87/6073, pp 136-149) **Measurements of thermophysical and mechanical properties of oil sands.** Scott, J.D.; Hsu, T. (Univ. of Alberta, Edmonton). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

A full set of mechanical and thermophysical properties of oil sands has been measured on good quality, undisturbed core samples at 20 C and mechanical properties have been measured at other temperature up to 300 C at the University of Alberta. A large increase in the modulus of elasticity with confining stress has been measured and a substantial difference in modulus and in the effective shear strength between drained tests and undrained tests has been noted. Poisson's ratio was between 0.25 and 0.30 over the full range of confining stresses and temperatures. Thermal expansion coefficients have been measured using high pore fluid pressures to keep gases and volatiles in solution over the full temperature range. Thermal conductivity, thermal diffusivity, and specific heat have been measured at varying degrees of saturation. Mechanical properties of oil sand and shale under dynamic loads were measured at the University of Manitoba. A specially designed pneumatic Split Hopkinson-Bar facility was used to provide dynamic (impact) loads to the specimen. Specimens of 38 mm dia x 19 mm long were tested under confining stresses up to 5 MPa. Compressive Young's modulus of these materials have shown significant increase with confining stresses and applied loading (strain) rates. Strain rates for these tests varied from 700 to 2000 per second. An increase of two orders of magnitude in the compressive Young's modulus of oil sand over its static conditions was observed at the maximum dynamic test condition, whereas the maximum compressive failure strength increased by 5 times. A similar trend was found in the results of shale material, although the effect of strain rates was somewhat moderate. 6 references, 16 figures.

20028 (DOE/METC—87/6073, pp 150-155) **Technique for the measurement of fracture toughness of oil sands.** Wilson, E.B.; Hsu, T.R. (Univ. of Manitoba, Winnipeg). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

Recent research effort by one of the authors (TRH) has indicated that it is possible to achieve effective fluid communication between wells with the aid of horizontal fractures started from appropriately shaped notches in the injection well bore. To predict the behavior of the fractures it is necessary to know the fracture characteristics of oil sand properties such as the fracture toughness. Special test rigs were designed, and techniques developed to measure this property under simulated in-situ conditions. Wedge-Loaded-Compact-Tension (WLCT) samples were made following the ASTM-E 399-83 specification. Typically they were 28 mm cubes with a 40° notch through half of their thickness. Specimens were contained in a custom made latex membrane which separated the specimen from pressurized fluid which provides a confining stress of 2 MPa. A 42° wedge was used to produce a cleavage type of fracture in the specimens. Using the same compliance function for the ASTM-E 399-83 compact tension specimens, the measured results yielded an average value of K/sub Ic/ = 27 kPa/m or 24.6 psi/in. 2 references, 6 figures, 1 table.

20029 (DOE/METC—87/6073, pp 156-168) **Viscosity predictions for gas-free Alberta bitumens using the corresponding states method.** Svrcek, W.Y.; Mehrotra, A.K. (Univ. of Calgary, Alberta). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The viscosities of four Alberta bitumens, namely Marguerite Lake, Athabasca, Peace River and Wabasca, are successfully predicted using the corresponding states method. The bitumens are modelled as mixtures of two, three and four pseudo components. The Kesler-Lee correlations and the method of Riedel are used to estimate the critical properties and acentric factor of each bitumen pseudo component. Using an aromatic-napthenic compound as the reference fluid and appropriate shape factors, the predicted bitumen viscosities compare satisfactory with the experimental viscosity data over a wide range of temperatures. The predictions are within 10% of the data over a viscosity range of 0.5 to 271 Pa.s. 23 references, 6 figures, 7 tables.

20030 (DOE/METC—87/6073, pp 204-222) **Saturated hydrocarbon distributions in bitumens and in oils recovered by thermal processes.** Holmes, S.A.; Romanowski, L.J. Jr.; Thomas, K.P. (Western Research Institute, Laramie, WY). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—). Contract FC21-83FE60177.

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The effect of processing conditions on oil recovery from tar sand has been studied recently by using a linear, adiabatic tube reactor. Laboratory experiments have been conducted to evaluate the potential of combustion and hot-gas injection for the thermal recovery of oil from the Asphalt Ridge and the Tar Sand Triangle deposits in Utah. The oil produced by reverse combustion of Asphalt Ridge tar sand contained 45 wt. % saturated hydrocarbons, and the oil produced by forward combustion of Tar Sand Triangle tar sand contained 40 wt. % saturated hydrocarbons. Results from field ionization mass spectrometric analysis of the saturates indicated significantly larger amounts of material with carbon numbers less than $C_{40}$ were present in both product oils from combustion than were present in the original bitumens. The saturates in these product oils were comprised of mostly acyclic alkanes, mono-, and dicycloalkanes. Carbon number distributions of tetracyclo- and pentacycloalkanes (biological markers) were similar for both the product oil recovered by reverse combustion and the bitumen from Asphalt Ridge. The hog-gas injection process produced a greater amount of oil, containing more saturated hydrocarbons, than either combustion process. Significant amounts of medium-molecular-weight material from $C_{15}$ to $C_{37}$ were present in oils produced by hot-gas injection. A comparison of the carbon number and Z-series distributions of saturates indicated that relatively greater amounts of branched alkanes and lower-numbered cyclic systems were present in product oils from combustion and hot-gas injection than in the original tar sand bitumens. 13 references, 5 figures, 5 tables.

20031 (DOE/METC—87/6073, pp 485-490) **Production of aviation turbine fuels from Utah and Kentucky bitumens.** Harrison, W.E. III. (Air Force, Wright-Patterson AFB, OH). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

This paper presents the results of the US Air Force program to determine the costs, yields, physical characteristics and chemical properties of aviation turbine fuels, Grades JP-4 and JP-8, produced from Kentucky and Utah bitumens. The bitumen was upgraded by the Ashland Petroleum Company and the Applied Research and Development Division of Sun Company for the Fuels Branch of the Aero Propulsion Laboratory at Wright-Patterson AFB Ohio. The results obtained in this program indicated that high quality aviation turbine fuels can be produced from tar sands bitumen. 4 references, 3 figures, 4 tables.

## 0406 Direct Uses And By-products

20032 (DOE/METC—87/6073, pp 353-362) **Preliminary assessment of agglomeration techniques for bitumen separation from storage tank sludge.** Majid, A.; Sparks, B.D. (National Research Council of Canada, Ottawa, Ontario). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The authors have developed a novel technique for the recovery of hydrocarbon components lost to the tailings streams of existing and proposed bitumen separation plants. This involves the use of hydrophobic materials as collectors for residual organics. Addition of finely divided hydrophobic particles to an agitated tailings slurry results in adsorption of the residual organic liquids by these collector solids. Continued mixing then results in agglomeration of these particles due to cohesion between the adsorbed films. The agglomerated solids can be readily separated from the bulk of the slurry on the basis of their particle size. As a result of the agglomeration process the hydrocarbon residues are concentrated into a more convenient form suitable for further treatment to recover the individual components or for use as an enriched fuel source. Storage tank sludge from a heavy oil project has been evaluated for the recovery of residual bitumen employing this techniques. Preliminary results indicate 80-90% recovery of residual bitumen. The quality of the agglomerated solids in terms of undesirable components, such as water and inorganic minerals was also investigated. Also, the treated slurries gave faster solid settling rates and improved drying characteristics for the thickened sediment. About 35% of the original water could be recovered from the treated samples after only 2-3 hours of settling. 13 references, 2 figures, 5 tables.

20033 (DOE/METC—87/6073, pp 491-501) **Utilization of synthetic crude processing residues in asphalt blends.** Sawatzky, H.; Poirier, M.A. (CANMET, Ottawa, Ontario). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The mode of utilization-disposal of processing residues is of paramount significance for the economic viabilities of synthetic crude operations. Incorporation in asphalt blends would appear to be ideal. Two types of processing residues are being considered. One is the refractory non-distillable residues (pitches) in synthetic crudes produced from bitumens/heavy oils/residuals by non-coking technologies. The other is the concentrates of nitrogenous components of synthetic crude gas oils obtained by extraction to produce raffinates that are more efficiently processed to transportation fuels. (These extracts represent about 4% of the gas oils and contain about 75% of the nitrogen). In the case of the pitches compatibilities with various base blending stocks to produce both road and roofing asphalts can be predicted by chemical characterization studies. These compatibilities and the amounts of pitch that can be blended depend on the processing technologies and severities. The addition of these pitches to the asphalt can substitute for air blowing which is of particular relevance to roofing asphalts. These studies include cohesion and temperature susceptibilities in addition to regular asphaltic properties. Similar studies have been carried out for the extracts of nitrogenous concentrates from gas oils. 9 references, 1 figure, 11 tables.

## 0407 Health And Safety

*REFER ALSO TO CITATION(S) 21100*

## 0408 Marketing And Economics

*REFER ALSO TO CITATION(S) 20021, 20022, 20041*

20034 (DOE/METC—86/6045, pp 53-57) **Australian perspectives on oil shale development.** Browning, J.V. (Southern Pacific Petroleum NL, Ogden, UT). Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—).

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

The prospects for a rise in oil prices sufficient to stimulate the oil shale program are reviewed. Oil reserves, especially those of the Middle East are considered. The author concludes that oil prices are not likely to be high enough to justify oil shale projects in the U.S. but that oil shale projects in Australia may make economic sense.

## 0409 Waste Research And Management

*REFER ALSO TO CITATION(S) 20032*

20035 (DOE/METC—87/6073, pp 324-352) **Application of marine geophysical techniques for monitoring tailings pond development at the Syncrude Canada Ltd. oil sands plant in N.E. Alberta.** McMullin, B.R.; MacKinnon, M.D.; Chekerda, L.J. (Syncrude Canada Ltd., Edmonton, Alberta). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The application of marine geophysical survey techniques to a wastewater tailings pond at an oil sands plant is described. The survey was conducted using a seismic reflection method at a low energy, high frequency signal for measuring the sludge to water interface and a high energy, low frequency signal for determining the solid pond bottom. Contour plots of the pond topography were generated and the total pond volume capacity was calculated. Also the sludge and free water volumes and the areas and volumes of each 1 m depth interval were determined. Slopes of tailings deposited underwater were obtained. This information is necessary for managing the rate of pond development and for assessing the results of present water and tailings management approaches used by Syncrude. 5 references, 14 figures, 6 tables.

20036 (DOE/METC—87/6073, pp 363-374) **Effect of water treatment alternatives on water demands for in situ production of bitumen.** Owen, T.E.; Humenick, M.J. (Arizona Public Service Co., Phoenix). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

Wastewater resulting from in situ production of tar sand bitumen using steam-drive or combustion processes must be treated before reuse within the production facility or discharge into the environment. The water requirements of the recovery facility depend largely on the recovery process and the treatment processes selected. With a 20,000 barrel-per-day production facility as the design basis, the water requirements for an in situ steam-drive and an in situ combustion production facility have been determined as a function of the wastewater treatment process used as each type of facility. For in situ steam-drive recovery, the makeup water requirement ranges from 1980 gallons per minute for hot-lime softening wastewater treatment to 2150 gallons per minute for strong acid ion exchange treatment. For in situ combustion recovery, the makeup water requirement ranges from zero gallons per minute for reverse osmosis wastewater treatment to 580 gallons per minute for biological treatment. 12 references, 8 figures, 3 tables.

## 0410 Environmental Aspects

*REFER ALSO TO CITATION(S) 20041*

20037 (DOE/METC—86/6045, pp 44-52) **Western Research Institute environmental research.** Poulson, R.E.; Sullivan, P.J.; Essington, M.E.; Hill, S.L.; Carroll, R.B.; Coomes, R.M. Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—). Contract FC21-83FE60177.

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

For the period August 1985 through September 1986 there are 55 scheduled milestones. Thirty-four have been completed. The remaining milestones, most of which are reports, are scheduled for completion by the end of next month, when the current cooperative agreement is scheduled for completion. Three research areas are discussed: gaseous emissions from spent shale, recarbonization of spent shale, and organic profiling of potential pollutants from an oil shale retorting operation.

20038 (DOE/METC—86/6045, pp 58-69) **Siting methodology: divergence and vorticity in the Rocky Mountain plateau circulation.** Barr, S. (Los Alamos National Lab., NM). Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—).

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

Early results from analysis of the ROMPEX data set suggest that a plateau circulation with characteristic dimensions of 500 km is a factor in the summertime wind fields over Colorado, Wyoming and New Mexico. Also, the deployment of sensors in exposed locations on mountain peaks appears to yield a representative sample of the regional scale circulation reflected in reasonable temporal and spatial patterns of derived quantities. The kinematic flow properties of divergence and vorticity are excellent diagnostics for interpreting the plateau circulation in the ROMPEX data set. Both parameters exhibit a clear diurnal variability as well as a suggested synoptic scale variability. The phase of the variations as well as the amplitudes are consistent with estimates based on the thermal forcing and resulting pressure fields. A comparison of forces suggests that the plateau circulation can represent everything from a dominance of the observed wind (when synoptic gradients are very weak) to an insignificant perturbation under vigorous synoptic flow. The practical implications of the circulation are significant. As in the case of the Piceance Basin observations described in Section I, transport winds can be in the opposite direction to those indicated by synoptic analysis exclusive of the circulation domain. The diurnal reversal characteristic suggests that pollutant plumes may pass a particular location more than once.

20039 (DOE/METC—86/6045, pp 70-77) **Role of shale type and process parameters in the formation and behavior of spent shale wastes.** Peterson, E.J. (Los Alamos National Lab., NM). Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—).

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

The objectives of this research are to determine the nature, magnitude, and time dependence of the major and trace element releases as functions of the raw shale mineralogy, retorting conditions, and spent shale mineral assemblages. These experimental studies focus on retorting variable regimes characteristic of most retorting processes. As an adjunct objective, the relation of laboratory results to those obtained from both bench-scale and pilot-scale retorts, when both have been operated under similar retorting conditions, are defined. The goal is to develop a predictive capability for spent shale chemistry as a function of the raw material feedstock and process parameters.

20040 (DOE/METC—86/6045, pp 211-230) **Field and laboratory leaching studies of Kentucky oil shales: progress report of laboratory studies.** Shirav, M.; Robi, T.L. Aug 1986. NTIS, PC A12/MF A01. File Number DE86006587. (CONF-860847—). Contract FC21-84MC21144.

From 2. annual oil shale contractors' meeting; Morgantown, WV, USA (12 Aug 1986).

The goal of the study is to provide information on the disposal characteristics of processed Kentucky oil shales. The results will have a bearing on the design practices and disposal scenarios utilized in the development of an eastern oil shale industry. The laboratory work is divided into two phases. The first phase is the examination of leachates from simple batch extraction techniques, such as those of the US Environmental Protection Agency (EPA) and the American Society for Testing Materials (ASTM). In the second phase, more extensive tests, employing techniques such as leaching columns that use a sample configuration similar to the field lysimeters are being devised.

### 0420 Regulations

20041 (DOE/METC—87/6073, pp 375-387) **Administrative, economic, environmental, and legal hurdles to tar sand development in Wyoming: a case study.** Barrell, S.S.; Stout, D.L.; Rosenlieb, G.W.; Hansen, H.; Heller, D.E. (Denver Federal Center, Lakewood, CO). Oct 1986. NTIS, PC A23/MF A01. File Number DE87001002. (CONF-860717—).

From 2. tar sand symposium; Jackson, WY, USA (8 Jul 1986).

The identification of a mineral deposit is often the least complex step in the process of mineral development. The Trapper Canyon Tar Sand Deposit, Big Horn County, Wyoming, has been recognized since the beginning of the twentieth century. Historically, the hydrocarbon resources have been subject to claim, lease, sale, and theft under a host of administrative, economic, and legal climates. Development of the mineral resource values contained have alternatively focused on oil, asphalt, tar sand, glass or silica sand, foundry sand, fracturing sand, rare-earth elements, and metallic minerals. Conflicting environmental sensitivities, renewable resource values, and wilderness, wildlife habitat, and watershed concerns contend with present development scenarios to produce a complex set of hurdles to overcome before production can capitalize on the resource values of the deposit. A set of steps is proposed to permit the orderly development of the deposit in more favorable economic times. 13 references, 3 figures, 2 tables.

## 05 NUCLEAR FUELS

### 0501 Reserves, Exploration, And Mining

*REFER ALSO TO CITATION(S) 20986*

### 0504 Feed Processing

*REFER ALSO TO CITATION(S) 20727*

20042 **(INIS-mf—10295) Uranium recovery from seawater. Preparing work of an experiment with a pilot plant in the sea (Phase 2: 1980-1984). Final report.** Bitte, J.; Fremery, M.I.; Kellner, A.; Schroeer, K.; Knippenberg, W. (Uranerzbergbau G.m.b.H. und Co. K.G., Bonn (Germany, F.R.)). Sep 1984. 411p. (In German). NTIS (US Sales Only), PC A18/MF A01. File Number DE87751263.

The present publication describes the development work of a process to recover uranium from seawater and the proposition of a commercial demonstration plant. The essential components of this process are verified in the laboratory scale as well as in some field tests. A detailed engineering design for a model plant in a semi-technical scale to allow field tests in the marine environment is also presented. These field tests are expected to produce more realistic data on the technical and economical feasibility of the proposed technology. Production cost estimates based on state-of-the-art technology lie around 250 Dollar/1b U/sub 3/O/sub 8/. However, the effect of a corresponding uranium price increase on electricity costs are comparable to cost increases in coal operated power plants caused by the desulfurisation of coal. Further reductions of the production costs in the range below 150 Dollar/1b U/sub 3/O/sub 8/ seem possible through special research efforts in the area of sorber development and concept design.

### 0505 Uranium Enrichment

20043 **(INPE—3915) Theoretical behavior of fully ionized multiple species magnetized plasmas under rotation.** (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). Jun 1986. 59p. NTIS (US Sales Only), PC A04/MF A01. File Number DE87700929.

A multiple species fluid model for a fully ionized, magnetized plasma under rotation is described. The basic fluid equations are the continuity and momentum equations for each species, including centrifugal, electromagnetic, pressure gradient and collisional forces, in cylindrical geometry. This model is used to describe the steady state behavior of the fully ionized cylindrical plasma column in a laser-initiated vacuum-arc plasma centrifuge. It is shown that there is a family of theoretically possible dynamical equilibrium configurations, which can be achieved by different combinations of ion rotation velocity radial ion density distribution and radial dependence of internal electric potential. A numerical analysis is presented which shows the radial distribution and parametric dependences of the various plasma parameters under equilibrium conditions, including the ion separation factor, considering a nickel-copper plasma. The numerical results are analyzed and discussed on light of experimentally measured plasma characteristics in a vacuum-arc plasma centrifuge.

### 0507 Fuels Production And Properties

*REFER ALSO TO CITATION(S) 20145, 22026*

20044 **Fabrication of high exposure nuclear fuel pellets.** Frederickson, J.R. (to Dept. of Energy, Washington, DC). US Patent 4,637,900. 20 Jan 1987. Filed date 13 Jan 1984. vp.

A method is described of making a fuel pellet for a nuclear reactor comprising (A) preparing a mixture of PuO/sub 2/ and UO/sub 2/ powders, the mixture containing at least about 30% PuO/sub 2/, where at least 12% by weight of the Pu is Pu/sup 240/; (B) adding to the mixture about 0.3 to about 5% of a binder having a melting temperature of at least about 250 F. selected from a group consisting of fatty acid diamides, polyvinyl caboxylate, polyvinyl alcohol, naturally occurring high molecular weight cellulosic polymers, chemically modified high molecular weight cellulosic polymers, and mixtures thereof; (C) pressing the mixture at about 5000 to about 25,000 psi to form a slug; (D) granulating the slug; (E) adding to the granulated slug a positive amount up to about 4.7% of a lubricant having a melting point of at least about 330°F., selected from the group consisting of fatty acid diamides, polyvinyl carboxylate, polyvinyl alcohol, naturally occurring high molecular weight cellulosic polymers, chemically modified high molecular weight cellulosic polymers, and mixtures thereof; (F) pressing the granulated slug at about 20,000 to about 70,000 psi to form a pellet; and (G) sintering the pellet at about 1700°C. +-200°C.

### 0508 Spent Fuels Reprocessing

*REFER ALSO TO CITATION(S) 20109, 20110, 20723*

20045 (CONF-8604121—, pp 78-80) **Nuclear communications: not too hot to handle.** Hoffman, W.D. (West Valley Nuclear Services Inc., NY). 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

West Valley, New York is the site of the world's only commercial nuclear fuel reprocessing plant. Its operation from 1966 to 1972 generated 600,000 gallons of liquid high-level nuclear waste. The West Valley Demonstration Project is charged with converting these wastes to a stable solid as well as decontaminating and decommissioning the plant. The US Department of Energy directs the work of the site operator, the West Valley Nuclear Services Company, part of the Westinghouse Waste Technology Services Division. This presentation discusses the programs in place at the West Valley Demonstration Project working to generate acceptance from the media, environmental groups, public officials, and the local community. The merits of an open versus a closed information policy are deliberated.

20046 **(DP-MS—86-157) Reprocessing of nuclear fuels at the Savannah River Plant.** Gray, L.W. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 4 Oct 1986. Contract AC09-76SR00001. 73p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006387.

For more than 30 years, the Savannah River Plant (SRP) has been a major supplier of nuclear materials such as plutonium-239 and tritium-3 for nuclear and thermonuclear weapons, plutonium-238 for space exploration, and isotopes of americium, curium,

and californium for use in the nuclear research community. SRP is a complete nuclear park, providing most of the processes in the nuclear fuel cycle. Key processes involve fabrication and cladding of the nuclear fuel, target, and control assemblies; rework of heavy water for use as reactor moderator; reactor loading, operation, and unloading; chemical recovery of the reactor transmutation products and spent fuels; and management of the gaseous, liquid, and solid nuclear and chemical wastes; plus a host of support operations. The site's history and the key processes from fabrication of reactor fuels and targets to finishing of virgin plutonium for use in the nuclear weapons complex are reviewed. Emphasis has been given to the chemistry of the recovery and purification of weapons grade plutonium from irradiated reactor targets.

20047 **(INIS-BR—574) Uranium and thorium separation in the chemical reprocessing of the irradiated fuel of thorium and uranium mixed oxides.** (Minas Gerais Univ., Belo Horizonte (Brazil)). Sep 1984. 98p. (In Portuguese). NTIS (US Sales Only), PC A05/MF A01. File Number DE87700922.

A bibliographic research has been carried out for reprocessing techniques of irradiated thorium fuel from nuclear reactors. The Thorex/Hoechst process has been specially considered to establish a method for reprocessing thorium-uranium fuel from PWR. After a series of cold tests performed in laboratory it was possible to set the behavior of several parameters affecting the Thorex/Hoechst process. Some comments and suggestions are presented for modifications in the process flosheet conditions. A discussion is carried out for operational conditions such as the aqueous to organic flow ratio the acidity of strip and scrub solutions in the process steps for thorium and uranium recovery. The operation diagrams have been constructed using equilibrium experimental data which correspond to conditions observed in laboratory.

20048 **MCNP analysis of the LSTDS system to determine its feasibility as a spent fuel assay device.** Fisher, H.O.M. Troy, NY; Rensselaer Polytechnic Institute (1986). 646p. University Microfilms Order No. 86-07,722.

Thesis (Ph. D.).

Monte Carlo Analysis of the Lead Slowing Down Time Spectrometer (LSDTS) in general, and of the Rensselaer Intense Neutron Spectrometer (RINS) system in particular, was performed in the 100 keV - 0.1 eV energy range. The parameter and functions that characterize and describe the operational behavior of the system were determined, compared to the Monte Carlo Neutron Photon (MCNP) data and found to be in generally good agreement in the assay range of interest. Questions concerning the applicability of the Gaussian approximation to represent the neutron energy distribution were overcome. The neutron energy resolution, average energy, and flux functions were determined and the assay and division sensitivities of the system calculated. Nonlinear least squares methods and techniques used to parameterize the MCNP data are included. Descriptions of the computer programs written to automate the analysis are also included. Although the presence of a full-size commercial fuel element inside the lead assembly modifies the neutron energy versus slowing down time relationship, the neutron energy resolution is still sufficient to assay the quantities of $^{235}U$ and $^{239}Pu$ in spent fuel. The LSDTS is thus a viable device for assaying spent fuel and is recommended for practical consideration to the nuclear industry.

## 0509 Transport And Storage

*REFER ALSO TO CITATION(S) 20140, 20824, 20843, 20915*

20049 **(CONF-870405—9) Automated shielding analysis sequences for spent fuel casks.** Tang, J.S.; Parks, C.V.; Hermann, O.W. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005511.

From Radiation protection and shielding conference; Knoxville, TN, USA (22 Apr 1987).

Two important Shielding Analysis Sequences (SAS) have recently been developed within the SCALE computational system. These sequences significantly enhance the existing SCALE system capabilities for evaluating radiation doses exterior to spent fuel casks. These new control module sequences (SAS1 and SAS4) and their capabilities are discussed and demonstrated, together with the existing SAS2 sequence that is used to generate radiation sources for spent fuel. Particular attention is given to the new SAS4 sequence which provides an automated scheme for generating and using biasing parameters in a subsequent Monte Carlo analysis of a cask.

20050 **(DOE/AL/33218—T7) [Analysis of transportation issues: Ninth bi-monthly report, January-February 1987].** (Western Interstate Energy Board, Denver, CO (USA)). 16 Mar 1987. Contract AC02-85AL33218. 189p. NTIS, PC A09. File Number DE87004856.

During the January-February 1987 reporting period, the contractor has spent most of its effort on Task 1 - Updates to the "Primer" and Task 2 - In-depth Analysis of Previously Identified Issues. The contractor has also been working to fulfill new requirements added to the contract during this reporting period related to transportation of transuranic wastes to the Waste Isolation Pilot Plant.

20051 **(DOE/OR/21561—1) Nuclear materials transportation project: Final technical report.** (Southern States Energy Board, Atlanta, GA (USA)). Feb 1987. Contract FG02-85OR21561. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87006166.

The Southern States Energy Board (SSEB), using the Western Interstate Energy Board's "Spent Nuclear Fuel and High-Level Radioactive Waste Transportation Primer" as a baseline of information, has produced a similar document updated and given a southern focus. SSEB, in consultation with the Joint Integration Office (JIO), designed and developed a computer software program to support JIO's institutional activities. The program, which operates with dBase III Plus on an IBM or compatible microcomputer, provides a mechanism for tracking staff commitments, actions in response to commitments and any related correspondence. In December 1985 and January 1986, SSEB asked its member governors and affected Indian tribes within the SSEB member states to designate appropriate representatives to serve on an Advisory Committee to SSEB on Radioactive Materials Transportation. This committee was established specifically to provide advice and comment to SSEB as it carries out the requirements of this grant. An Atlas of Routes was developed to provide the latest available routing information applicable to SSEB's 16 contiguous member states. The report includes detailed routing information on each of the South's 27 reactor sites and their expected mode of transport, highway or rail. The highway corridor impacts from reactors outside the region are also assessed. The report focuses only on predicted highway and rail routes and includes no other shipment data or other risk assessments or analysis. (LM)

20052 **(FRADOC—9-6) High density aseismic spent fuel storage racks.** Louvat, J.P. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). May 1985. 19p. (CONF-850555—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751005.

From International conference on engineering developments in reactor refuelling; Newcastle-upon-Tyne, UK (13 May 1985).

After the reasons of the development of high density aseismic spent fuel racks by Framatome and Lemer, a description is presented, as also the codes, standards and regulations used to design this Framatome storage rack. Tests have been carried out concerning criticality, irradiation of Cadminox, corrosion of the cell, and the seismic behaviour.

20053 **(IAEA-R—4152-F) Assessing the INTERTRAN code for application in Asian environs. Final report for the period 1 July 1985-30 June 1986.** (International Atomic Energy Agency, Vienna (Austria)). Oct 1986. 41p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700888.

A Japanese study, which was carried out as part of the IAEA Coordinated Research Programme on Radiation Protection Implications of Transport Accidents Involving Radioactive Materials, provided evaluations of transport conditions of nuclear fuel in

Japan. Nuclear fuel is transported in Japan in the form of UO/sub 2/, UF/sub 6/, fresh fuel assemblies and spent fuel. Based on these transport conditions calculations were made using the INTERTRAN code which was developed as part of the IAEA Coordinated Research Programme on Safe Transport of Radioactive Materials (1980-1985), for assessing doses to workers and to the public due to the transport of nuclear fuel. As a part of the study, a new code was developed for evaluating radiological impacts of the transport of radioactive materials. The code was also used for assessing doses from the transport of nuclear fuel in Japan. The results indicate that doses to workers and to the public due to the incident-free transport of nuclear fuel are low, i.e., of the order of 1-30 man mSv/100 km. The doses calculated by the Japanese code were in general slightly smaller than the doses calculated using the INTERTRAN code. The study concerned normal conditions of transport, i.e., no impact from incidents or accidents was evaluated. The study resulted, in addition, in some suggestions for further developing the INTERTRAN code. 12 figs, 9 tabs.

20054 **(IAEA-TECDOC—389) Directory of national competent authorities' approval certificates for packages, shipments, special arrangements and special form radioactive material.** (International Atomic Energy Agency, Vienna (Austria)). Sep 1986. 156p. NTIS (US Sales Only), PC A08/MF A01. File Number DE87700890.

The Agency's transport regulations prescribe various requirements for the authorization of packages and shipments in respect of both national and international movement of radioactive materials. These authorizations are issued by the relevant competent authority of the country concerned; they take the form of package approval and/or shipment approval certificates. At the request of the Standing Advisory Group of the Safe Transport of Radioactive Material (SAGSTRAM), the Agency has established a programme to maintain a file of those certificates for packages and shipments which are either transported internationally or used outside the country of origin. The purpose of this directory is to facilitate the transfer of information to competent authorities and any other person wishing details on the packaging, authorized contents or special conditions pertinent to any package or shipment. The directory enables competent authorities to be aware of the status of any certificate submitted for validation. It also indicates any change in status of any certificate already validated. Future updates of the complete data will be distributed annually in a TECDOC form and, in addition, summary listings of the certificates will be issued every six months thereafter. 7 tabs.

20055 **(JEN—589) Calculation of source term in spent PWR fuel assemblies for dry storage and shipping cask design.** (Junta de Energia Nuclear, Madrid (Spain)). 1986. 64p. (In Spanish). NTIS (US Sales Only), PC A04/MF A01. File Number DE87701465.

Using the Origen-2 code, the decay heat and neutron and photon sources for an irradiated PWR fuel element have been calculated. Also, parametric studies on the behaviour of the magnitudes with the burn-up, linear heat power and irradiation and cooling times were performed. Finally, a comparison between our results and other design calculations shows a good agreement and confirms the validity of the used method. 18 figs., 6 refs.

20056 **(PNL-SA—14350) Effect of burnup level on oxidation of LWR [light-water reactor] spent fuel.** Campbell, T.K.; Gilbert, E.R.; Knox, C.A. (Pacific Northwest Lab., Richland, WA (USA)). Feb 1987. Contract AC06-76RL01830. 7p. (CONF-870306—33). NTIS, PC A02. File Number DE87006431.

From Waste management '87; Tucson, AZ, USA (1 Mar 1987).

Oxidation tests on bare pressurized water reactor (PWR) and boiling water reactor (BWR) spent fuel fragments under static air cover gas conditions are being conducted in the presence of a $10^5$ R/h gamma field. Test temperature levels are between 135°C and 230°C. Visual examination of the 230°C BWR specimens revealed that the period time to form low-density powder increased with increasing burnup level for burnups between 8 and 34 GWd/MTU. Cumulative weight gain data up to 5 wt %, however, was essentially independent over the same burnup range. The PWR fuel specimens did not form powder after 4000 hours of exposure; thus, powder formation appears to occur earlier on BWR fuels.

20057 **(SAND—86-2222C) A simplified modeling technique for the thermal analysis of spent nuclear assemblies.** Sanchez, L.C. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 13p. (CONF-870306—41). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006900.

From Waste management '87; Tucson, AZ, USA (1 Mar 1987).

A major design concern of a cask for the transport of spent fuel assemblies is the determination of the maximum fuel pin temperature. Normally the determination of the maximum steady state fuel pin temperature requires the thermal analysis (two-dimensional or three-dimensional) of the cask to be performed in conjunction with the fuel assemblies. This, in general, would require extensive effort and computer time. However, by performing a sensitivity analysis for fuel pin temperature for various boundary conditions it was possible to decouple the heat transfer analysis of the cask from that of the fuel assemblies. This paper presents the scaling law that was obtained for maximum fuel pin temperature as a function of emissivity, heat generation rate and assembly wrapper temperature for hex-shaped fuel assemblies.

## 0520 Waste Management

*REFER ALSO TO CITATION(S) 20045, 20137, 20138, 20657, 20665, 20738, 20740, 20828, 20935, 21117, 21118, 21240, 21242, 21243, 21272*

20058 **(ANL—86-50) Sodium waste technology: A summary report.** Abrams, C.S.; Witbeck, L.C. (Argonne National Lab., IL (USA)). [1987]. Contract W-31109-ENG-38. 76p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87006581.

The Sodium Waste Technology (SWT) Program was established to resolve long-standing issues regarding disposal of sodium-bearing waste and equipment. Comprehensive SWT research programs investigated a variety of approaches for either removing sodium from sodium-bearing items, or disposal of items containing sodium residuals. The most successful of these programs was the design, test, and the production operation of the Sodium Process Demonstration Facility at ANL-W. The technology used was a series of melt-drain-evaporate operations to remove nonradioactive sodium from sodium-bearing items and then converting the sodium to storable compounds.

20059 **(BMI/ONWI—618) Description of floodplains and wetlands, Deaf Smith County site, Texas.** (NUS Corp., Gaithersburg, MD (USA); Battelle Memorial Inst., Columbus, OH (USA). Office of Nuclear Waste Isolation). Nov 1986. Contract AC02-83CH10140. 58p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006595.

Floodplains and wetlands are important features of the Texas Panhandle landscape, and are found on the Deaf Smith County site and in its vicinity. Use or disturbance of floodplains and wetlands in relation to the Civilian Radioactive Waste Management Program is subject to environmental review requirements implementing two Executive Orders. This report provides general information on playa wetlands in the Texas Panhandle, and describes and maps floodplains and wetlands on the Deaf Smith site and in its vicinity. The report is based on the published literature, with information from limited field reconnaissance included.

20060 **(BMI/ONWI—620) Disposal alternatives and recommendations for waste salt management for repository excavation in the Palo Duro Basin, Texas.** (NUS Corp., Gaithersburg, MD (USA); Battelle Memorial Inst., Columbus, OH (USA). Office of Nuclear Waste Isolation). Jan 1987. 164p. NTIS, PC A08/MF A01. File Number DE87006594.

This report documents an evaluation of five alternatives for the disposal of waste salt that would be generated by the construction of a repository for radioactive waste in underground salt deposits at either of two sites in the Palo Duro Basin, Texas. The alternatives include commercial disposal, offsite deep-well injection,

disposal in abandoned mines, ocean disposal, and land surface disposal on or off the site. For each alternative a reference case was rated - positive, neutral, or negative - in terms of environmental and dependability factors developed specifically for Texas sites. The factors constituting the environmental checklist relate to water quality impact, water- and land-use conflicts, ecological compatibility, conformity with air quality standards, and aesthetic impact. Factors on the dependability check-list relate to public acceptance, the adequacy of site characterization, permit and licensing requirements, technological requirements, and operational availability. A comparison of the ratings yielded the following viable alternatives, in order of preference: (1) land surface disposal, specifically disposal on tailings piles associated with abandoned potash mines; (2) disposal in abandoned mines, specifically potash mines; and (3) commercial disposal. Approaches to the further study of these three salt management techniques are recommended.

20061 (CONF-870306—32) **The MRS [Monitored Retrievable Storage] task force: Economic and non-economic incentives for local public acceptance of a proposed nuclear waste packaging and storage facility.** Peelle, E. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006614.

From Waste management '87; Tucson, AZ, USA (1 Mar 1987).

A joint Oak Ridge - Roane County citizen task force (TF) evaluated the Department of Energy's (DOE) proposal to site a Monitored Retrievable Storage facility in Tennessee in terms of environmental, transportation, and socioeconomic impacts. The case study examines how the TF used mitigation, compensation end incentives (economic and non-economic) to address the problem of distrust of DOE and to change the net local impact balance from negative to positive. Intensive group interaction during their investigations and development of trust within the TF led to consensus decisions on safety and conditional acceptance. DOE accepted most of the TF conditions after informal negotiations. The siting process was stopped by extensive state-wide opposition resulting in legal challenge by the state and vetoes by the governor and state legislature.

20062 (CONF-8604121—, pp 21-23) **Lessons from past experiences: Texas.** Blackburn, T.W. III. (Texas Low-Level Radioactive Waste Disposal Authority, Austin). 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

A site selection study was conducted in which technical criteria were developed and potential sites numerically ranked. Three candidate sites were chosen, two in south Texas and one in west Texas. Adamant public opposition to the two sites forced a reevaluation and redirection of the siting process. Three sites on state owned lands in west Texas have been identified under the second site selection study. The following are recommended guidelines to incorporate in any public participation program: use multiple approaches at both the regional and local level; identify the public and their true concerns; approach the public at their level and their style; use a slow, deliberate process, siting cannot be forced; be honest and available; give the public an active part in the decision making process; keep elected officials informed and active and encourage information exchange; and be prepared for surprises. Two ranking exercises were also undertaken and are briefly described. The first ranked eleven major issues in order of perceived importance. The second ranked waste disposal technologies. Detailed information on both ranking exercises can be obtained from the Texas Low-Level Radioactive Waste Disposal Authority.

20063 (CONF-8604121—, pp 24-32) **Minnesota's experiences in siting hazardous waste facilities.** Dunn, R.G. (Minnesota Waste Management Board, Princeton). 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

In the 1970's two major siting controversies occurred in Minnesota, the siting of a demonstration Hazardous Waste Disposal Facility and the routing of a power line from North Dakota through the west central part of the state. In both, the public was belatedly involved. In 1980 when the state legislature undertook to develop a process to provide hazardous waste disposal, collection, treatment, and storage facilities, a comprehensive public education and participation effort was built into the siting plan. This paper describes the public education program and its performance and cites the major causes for successes and failures in several communities. The program included not only the citizens and local governments of Minnesota, but also those of the neighboring states and provinces of Canada.

20064 (CONF-8604121—, pp 33-44) **Lessons from past experiences: the critical path - a third party perspective.** Vincenti, J.R. (Pennsylvania State Univ., University Park). 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

When most people are confronted with the question, "What do you think about the low-level radioactive waste disposal issue facing your state," the first reaction is one of concern and fear for public health and environmental safety. This reaction, though very common, is but a small part of a complex scenario of social and technical issues that face those who generate and those who are responsible for the disposal of hazardous and toxic waste in America. This paper discusses: 1) ten lessons that the PIER (Public Involvement and Education on Radiation) Program at Penn State has experienced since its inception back in November of 1983; 2) the role of a university as a third party in controversial issues; 3) understanding the public and influential people - what they think and their differences; 4) the importance of interacting with the news media; and 5) the bottom line summary of the important parts of continuing education programs to the public.

20065 (CONF-8604121—, pp 45-48) **Virginia's experiences in siting radioactive waste facilities.** Wrenn, B. (Virginia Solid Waste Commission, Richmond). 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

The Virginia public participation program was developed in conjunction with the 1982 siting study for disposal of low-level radioactive waste. The announcement of sixteen counties within the Piedmont Plateau area as the candidate region coincided with the Christmas holidays and was little noticed by the public. Attendance increased as siting activities progressed. The Virginia experience identified several key points to incorporate into the public participation program: identify the public to be solicited; define the level of commitment, both personnel and budget; identify budget constraints; and understand the legal requirements.

20066 (CONF-8604121—, pp 49-50) **Mechanisms and techniques for public involvement in New Jersey.** Gimello, R. (New Jersey Siting Commission, Trenton). 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

The New Jersey Siting Commission has had the responsibility for the number, type, and location of hazardous waste disposal facilities. The Commission was formed in New Jersey for the purpose of promoting public participation in the siting process. The 1980 New Jersey Siting Act identifies these responsibilities: preparing a management plan or needs survey; describing the siting process - application of criteria on a statewide scale; completing onsite investigation by this summer; and choosing 2-3 communities. The Act states that a $50 thousand grant will be issued to the municipality selected as a site location to be used to contest the designation. After identification of the eleven potential sites, public meetings were held in April, May, and June. Because a number of states were experiencing problems with siting and public involvement, twenty states formed a consortium. This consortium was formed at the state level to help states remain informed on the issues surrounding development of hazardous waste disposal sites and to continue accurate information exchange. During this whole process, it is important to document decisions and bring the public along in the decision-making process, even if they don't agree.

20067 (CONF-8604121—, pp 51-52) **Mechanisms and techniques for public involvement in Pennsylvania.** Hunt, M. (Pennsylvania Dept. of Environmental Resources, Harrisburg). 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

In Pennsylvania, a successful public participation program on the hazardous waste issue was organized in the form of a Hazardous Waste Citizens Advisory Group. This advisory group developed a plan for a disposal facility that included siting criteria for the disposal site, public environment policy, permitting requirements, and Superfund policy. Some of the success of the Pennsylvania program rests with the fact that the governor supports the hazardous waste program. Pennsylvanians have found that the success of a public participation program depends on commitment from the top leadership in the state. This top leadership must seriously consider public recommendations on hazardous waste disposal and must encourage consistency in the public participation program statewide. Public participation must not be confused with public relations. Public relations reaches only in an outward direction. Public participation is a two-way street. It was found that there is more support for a public participation program if the public develops the criteria for the program.

20068 (CONF-8604121—, pp 53-62) **Barriers to public participation.** Patten, E. 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

When one talks of public involvement, one immediately thinks of a public hearing. Six problems with the public hearing system are listed and discussed. The constraints involved in the public hearing process are: 1) asking for technical information from general folks; 2) overwhelming the public with complex information; 3) having a format that intimidates the speaker and allows no opportunity for useful dialogue; 4) obtaining a skewed picture of an issue because one hasn't had truly representative comments; 5) citizens having overblown expectations of what public involvement means, and becoming frustrated and cynical when their advice isn't heeded; and 6) convincing the powers that be that a comprehensive program is a wise investment. The second half of this paper lists 21 other forms of public participation, giving a description of each form, its purpose, and brief comments on its advantages.

20069 (CONF-8604121—, pp 63) **Role of conflict in decision making.** Bellman, H.S. (Wisconsin State Dept. of Industry, Labor, and Human Relations, Madison). 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

In the siting process for a low-level waste disposal facility, there is a place for conflict, negotiation, arbitration, and public involvement. Contrary to popular belief, conflict is good. It signals pluralism and demonstrates a distribution of power. Conflict should not be eliminated because it is a dynamic method of decision-making. Conflict causes negotiation, which leads to compromise. Conflict is the product of the legitimacy of dissent.

20070 (CONF-8604121—, pp 64-65) **Negotiating through conflict.** Cormick, G.W. (Mediation Institute, Seattle, WA). 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

There are several major causes of conflict over the nuclear waste disposal siting process but conflict should not be ended or avoided merely to have peace. A number of issues are listed that should be addressed to ensure that negotiations can be performed in a manner that will result in agreements. During the negotiation process, participants should not reveal all secrets, but must not appear to be holding things back. The agreements reached as a result of negotiations should be spelled out clearly, in writing. The agreement should tell how to implement the decision and state how all parties will be involved. The agreement should also contain provisions for continued interaction among parties.

20071 (CONF-8604121—, pp 66) **Public interest group involvement.** Shelley, P. (Conservation Law Foundation of New England, Inc., Boston, MA). 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

Including public interest groups in the siting process for nuclear waste disposal facilities is of great importance. Controversial sitings often result in litigation, but involving public interest groups early in the process will lessen the change of this. They act as surrogates for the general public and should be considered as members of the team. It is important to remember though, that all public interest groups are different. In choosing public panels such as public advisory committees, members should not be chosen on the basis of some quota. Opposition groups should not be excluded. Also, it is important to put the right person in charge of the committee. The goal of public involvement is to identify the conflicts. This must be done during the decision process, because conflicts must be known before they can be eliminated. Regarding litigation, it is important to ease through and around legal battles. If the siting process has integrity and a good faith effort has been shown, the court should uphold the effort. In addition, it is important to be negotiable and to eliminate shortcuts.

20072 (CONF-8604121—, pp 67) **Conflict resolution: panel discussion and questions from the audience.** 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

Several questions were raised following the speakers' presentations. The question arose as to whether Congress should have let the 1986 milestone in the original Act occur, rather than drafting the Amendments Act in an effort to alleviate a potential problem. Generally, response held that allowing things to run their course would have raised pertinent issues, caused conflict, and ultimately resulted in negotiation and compromise. A question was raised about managing the transition from public involvement and participation to actual negotiations. The speakers responded that negotiation is a necessary step after informing the public. Letting people vent their frustrations is important but does not solve the problems. Controversy can result from public participation as easily as may consensus, because of value disagreements. The next step is to bargain and negotiate after the information is shared. The speakers were then asked how they felt about enforced (by state statute) mediation. All speakers responding felt that by building in mandatory mediation, the process is hurt more than helped. Mediation only works if all parties want it.

20073 (CONF-8604121—, pp 69-77) **How to work through the news media.** Chapman, M. (Credibility Consultants, Denver, CO). 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

There are essentially four steps that anyone must follow if the objective is to communicate a message through the news media: 1) Understand media (adversarial relationship, code of ethics, importance of First Amendment); 2) Redefine the relationship (become acquainted with reporter, save steps for the reporter); 3) Communicate clearly; and 4) Use alternatives when appropriate. These four steps are discussed.

20074 (CONF-8604121—, pp 81-89) **Low-level nuclear waste in Washington State.** Williams, H. (Seattle Times, WA). 1986. NTIS, PC A07/MF A01. File Number DE87000279.

From Conference on the critical path in siting controversial facilities; New Orleans, LA, USA (2 Apr 1986).

A commercial disposal site for low-level nuclear wastes opened at Hanford in 1965. By 1971 a total of six were in operation: Hanford, Nevada, South Carolina, Kentucky, New York State, and Illinois. The history of the operation of these sites is described. Only the first three listed are still open. The effects of the large volumes of waste expected from Three Mile Island are described. This paper examines the case history of Hanford operations

with low-level waste disposal for lessons that might apply in other states being considered for disposal sites.

20075 **(DOE/CH—10140-05(86)) Bibliography of studies for the Salt Repository Project Office of the Civilian Radioactive Waste Management Program, April 1978-May 1986.** (Battelle Memorial Inst., Columbus, OH (USA). Office of Nuclear Waste Isolation). Oct 1986. 357p. NTIS, PC A16/MF A01; 1; GPO Dep. File Number DE87006597.

DOE/CH/10140-05 is an annotated bibliography of approved reports that have been produced for the US Department of Energy Salt Repository Project Office of the Civilian Radioactive Waste Management Program since April 1978. This document is intended for use by the US Department of Energy, State and local officials, the US Nuclear Regulatory Commission, contractors to the Office of Nuclear Waste Isolation, concerned citizens, and others who need a comprehensive listing of reports related to a nuclear waste repository in salt. This document consists of a main report listing, appendixes with Work Breakdown Structure lists, and a topical index.

20076 **(DOE/CH/10140—06) Geochemistry Review Panel report on the SRP geochemistry program and draft geochemistry summary program plan (May, 1986) and discussion of panel recommendations.** (Solar Energy Research Inst., Golden, CO (USA)). Dec 1986. Contract AC02-83CH10140. 348p. NTIS, PC A15/MF A01; 1; GPO Dep. File Number DE87006730.

The Geochemistry Review Panel (GRP) was established by the Salt Repository Project Office (SRPO) to help evaluate geochemistry-related issues in the US Department of Energy's nuclear waste repository program. The May 1986 meeting of the GRP reviewed the Salt Repository Program (SRP) geochemistry program developed by the Office of Nuclear Waste Isolation (ONWI). This program is described in the Draft Geochemistry Plan of April 9, 1986. This report documents the GRP's comments and recommendations on this subject and the ONWI responses to the specific points raised by the GRP.

20077 (DOE/ER/60152—1-Pt.2, pp 430-440) **Mass transport in low permeability rocks under the influence of coupled thermomechanical and hydrochemical effects - an overview.** Tsang, C.F. (Lawrence Berkeley Lab., CA). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The present paper gives a general overview of mass transport in low permeability rocks under the coupled thermomechanical and hydrochemical effects associated with a nuclear waste repository. A classification of coupled processes is given. Then an example of a coupled process is presented. Discussions of coupled processes based on a recent LBL Panel meeting are summarized. 5 references, 3 figures, 4 tables.

20078 (DOE/ER/60152—1-Pt.2, pp 441-448) **New three dimensional model for flow in fractured rock.** Dershowitz, W.S.; Gordon, B.M.; Kafritsas, J.C.; Herda, H. (Massachusetts Institute of Technology, Cambridge). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

This paper presents a new three dimensional model for the geometry of networks of fractures in a rock mass. The model is an extension of a model developed by Veneziano (1979). The model is compared against existing models on the basis of geological observations, and is implemented in a finite element program for calculation of hydrologic properties of rock masses. Example simulations are presented. 11 references, 9 figures.

20079 (DOE/ER/60152—1-Pt.2, pp 449-462) **Hydrologic behavior of fracture networks.** Long, J.C.S.; Endo, H.K.; Karasaki, K.; Pyrak, L.; MacLean, P.; Witherspoon, P.A. (Lawrence Berkeley Lab., CA). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

This paper reviews recent research on the nature of flow and transport in discontinuous fracture networks. The hydrologic behavior of these networks has been examined using two- and three-dimensional numerical models. The numerical models represent random realizations of fracture networks based on statistical field measurements of fracture geometry and equivalent hydraulic aperture. The authors have compared the flux and mechanical transported behavior of these networks to the behavior of equivalent continua. In this way they were able to determine whether a given fracture network could be modeled as an equivalent porous media in both flux and advective transport studies. They have examined departures from porous media behavior both as a function of interconnectivity and heterogeneity. Parameter studies have revealed behavior patterns such as: given a fracture frequency that can be measured in the field, porous media like behavior and the magnitude of permeability are both enhanced if the fractures are longer and the standard deviation of fracture permeabilities is smaller. The behavior of well tests in fractured networks has been modeled and compared to a new analytical well test solution which accounts for the early time dominance of the fractures intersecting the well. Finally, a three-dimensional fracture flow model has been constructed which assumes fractures are randomly located discs. This model has been constructed which assumes fractures are randomly located discs. This model uses a semi-analytical solution for flow such that it is relatively easy to use the model as a tool for stochastic analysis. 13 references, 12 figures.

20080 (DOE/ER/60152—1-Pt.2, pp 463-372) **Evaluating the hydraulic conductivity of fractured rock from information on fracture geometry.** Shapiro, A.M.; Bear, J. (Geological Survey, Reston, VA). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

In some fractured rock formations which may be treated by using the continuum hypothesis, the density of fracturing may be sparse in comparison to the length scale of a given measuring device. Therefore, the minimum volume which is indicative of the continuum scale, i.e., a Representative Elementary Volume (REV), is larger than the measuring instrument. The interpretation of measurements taken under such conditions becomes questionable in terms of their use in estimating continuum parameters such as hydraulic conductivity. A method for estimating the hydraulic conductivity of a fractured rock is formulated from a knowledge of the fracture geometry. The basis of this approach is the averaging of the equation of linear momentum for the fluid in the fractures over the REV. The hydraulic conductivity tensor which results is defined solely in terms of the fracture geometry, and it exhibits the effect of the orientation of the individual fractures, and also the effect that arises due to gradients of the fluid potential in the individual fractures which are not necessarily the same as the gradient of the average fluid potential, which is the driving force for flow at the continuum level. Although the explicit tensorial nature of the conductivity can be defined from a given fracture geometry, the geometric characteristics of the fractures will not be known exactly. Therefore, one must propose that the fracture conductivity be defined in terms of an assumed stochastic fracture geometry, which will allow an uncertainty associated with the conductivity values, based on the uncertainty associated with the fracture geometry. 16 references, 3 figures.

20081 (DOE/ER/60152—1-Pt.2, pp 473-485) **Effect of deformability on fluid flow through a fractured-porous medium.** Tsang, C.F.; Noorishad, J.; Witherspoon, P.A. (Lawrence Berkeley Lab., CA). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2). Contract AC03-76SF00098.

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

A permeable geologic medium containing interstitial fluids generally undergoes deformation as the fluid pressure changes. Depending on the nature of the medium, the strain ranges from infinitesimal to finite quantities. This response is the result of a coupled hydraulic-mechanical phenomenon which can basically be formulat-

ed in the generalized three-dimensional theory of consolidation. Dealing mainly with media of little deformability, traditional hydrogeology accounts for medium deformability as far as it affects the volume of pore spaces, through the introduction of a coefficient of specific storage in the fluid flow equation. This treatment can be justified on the basis of a one-dimensional effective stress law and the assumption of homogeneity of the total stress field throughout the medium. The present paper uses a numerical model called ROCMAS (Noorishad et al., 1982; Noorishad e al., 1984) which was developed to calculate fluid flow through a deformable fractured-porous medium. The code employs the Finite Element Method based on a variational approach. It has been verified against a number of simple analytic solutions. In this work, the code is used to address the role of medium deformability in continuous and pulse testing techniques. The errors that may result because of application of traditional fluid flow methods are discussed. It is found that low pressure continuous well testing or pulse testing procedures can reduce such errors. 16 references, 9 figures, 1 table.

20082 (DOE/ER/60152—1-Pt.2, pp 486-497) **Modeling of strongly heat-driven flow in partially saturated fractured porous media.** Pruess, K.; Tsang, Y.W.; Wang, J.S.Y. (Lawrence Berkeley Lab., CA). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2). Contract AC03-76SF00098.

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The authors have performed modeling studies on the simultaneous transport of heat, liquid water, vapor, and air in partially saturated fractured porous media, with particular emphasis on strongly heat-driven flow. The presence of fractures makes the transport problem very complex, both in terms of flow geometry and physics. The numerical simulator used for their flow calculations takes into account most of the physical effects which are important in multi-phase fluid and heat flow. It has provisions to handle the extreme non-linearities which arise in phase transitions, component disappearances, and capillary discontinuities at fracture faces. They model a region around an infinite linear string of nuclear waste canisters, taking into account both the discrete fractures and the porous matrix. From an analysis of the results obtained with explicit fractures, they develop equivalent continuum models which can reproduce the temperature, saturation, and pressure variation, and gas and liquid flow rates of the discrete fracture-porous matrix calculations. The equivalent continuum approach makes use of a generalized relative permeability concept to take into account the fracture effects. This results in a substantial simplification of the flow problem which makes larger scale modeling of complicated unsaturated fractured porous systems feasible. Potential applications for regional scale simulations and limitations of the continuum approach are discussed. 27 references, 13 figures, 2 tables.

20083 (DOE/ER/60152—1-Pt.2, pp 498-512) **Stochastic groundwater flow modeling using the second-order method.** Sagar, B.; Clifton, P.M. (Rockwell Hanford Operations, Richland, WA). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Stochastic groundwater flow modeling by means of a second-order uncertainty analysis techniques is discussed. This technique is based on a Taylor series expansion of the state variables of interest about the expected values of the model parameters. The method has been incorporated into the computer code PORSTAT, which solves the two-dimensional stochastic groundwater flow equation coupled with the deterministic heat transfer and mass transport equation using integrated finite differences coupled to a direct-equation solver. Uncertain variables that can be considered in the application of PORSTAT are (1) hydraulic conductivities (x- and y-direction), (2) specific storage, (3) boundary conditions, and (4) initial conditions. The output from PORSTAT consists of the expected values, variances, and covariances of hydraulic heads and Darcian velocities. The application of PORSTAT to a sample problem is also presented. This problem was also solved by means of a Monte Carlo groundwater flow program (PORMC) to assess the accuracy of the second-order method. It was observed that as the coefficient of variation of the input parameters increases, the difference between the standard deviations predicted by PORSTAT and those predicted by Monte Carlo codes increases. For coefficients of variation of hydraulic conductivity in these test cases of less than about one, the agreement between the results of PORSTAT and Monte Carlo codes appear to be reasonably close. 16 references, 12 figures.

20084 (DOE/ER/60152—1-Pt.2, pp 513-526) **General approach for modeling solute transport in structured soils.** van Genuchten, M.T. (Salinity Lab., Riverside, CA). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Classical convective-dispersive type transport models are often found to be of limited use for predicting in structured soils or fractured aquifer systems. Recently a number of deterministic two-region type models have appeared in the literature that consider transport in structured soils from a microscopic (macropore-scale) point of view. In these models, the chemical is assumed to be transported through a single pore or crack of known geometry, or through the voids between well-defined, uniformly-sized aggregates. In addition, diffusion-type equations are used to describe solute transfer from the larger pores into the soil matrix. This paper describes a method that extends the two-region modeling approach to more general conditions involving aggregates of arbitrary geometry. The method is based on the use of a geometry-dependent shape factor (f) that transforms an aggregate of given shape and size (platy, columnar, prismatic) into an equivalent sphere with similar diffusion characteristics as the original aggregate. Using conversions between known analytical solutions as test cases, the transformation was found to very accurate for most aggregate geometries commonly encountered in the field. A similar transformation was also used to quantify the unknown mass transfer coefficient in a previously employed first-order rate expression for solute exchange between mobile (interaggregate) and immobile (intra-aggregate) regions. 19 references, 8 figures, 1 table.

20085 (DOE/ER/60152—1-Pt.2, pp 527-537) **Mechanical transport and porous media equivalence in anisotropic fracture networks.** Endo, H.K.; Witherspoon, P.A. (Lawrence Berkeley Lab., CA). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2). Contract AC03-76SF00098.

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The objective of this work is to investigate the directional characteristics of hydraulic effective porosity in an effort to understand porous medium equivalence for continuous and discontinuous fracture systems. Continuous systems contain infinitely long fractures. Discontinuous system consist of fractures with finite lengths. The distribution of apertures (heterogeneity) has a major influence on the degree of porous medium equivalence for distributed continuous and discontinuous systems. When the aperture distribution is narrow, the hydraulic effective porosity is slightly less than the total porosity for continuous systems, and greater than the rock effective porosity for discontinuous systems. However, when heterogeneity is significant, the hydraulic effective porosity is directionally dependent and greater than total porosity for both systems. Nonporous medium behavior was found to differ for distributed continuous systems and for continuous systems with parallel sets. For the latter systems, hydraulic effective porosity abruptly decreases below total porosity in those particular directions where the hydraulic gradient and the orientation of a fracture set are orthogonal. The results for the continuous systems with parallel sets also demonstrate that a system that behaves like a continuum for fluids flux may not behave like a continuum for mechanical transport. 3 references, 13 figures.

20086 (DOE/ER/60152—1-Pt.2, pp 538-546) **New continuum approach for modeling dispersion in fractured media.** Schwartz, F.W.; Smith, L. (Univ. of Alberta, Edmonton, CA). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Continuum models in general provide the only practical approach to modeling dispersion in large, fractured rock systems. However, the conventional approach based on a simple diffusional model of dispersion suffer from important limitations in representing the dispersion process. A new continuum approach has been developed that more realistically accounts for the influence of fractures and fracture geometries on the pattern of dispersion. The technique involves particle tracking where the particular motion of a large number of reference particles in the continuum is determined by the statistical characteristics of the network and specific features of low velocities in fractures. Detailed information on the pattern of directed random motion of particles requires the use of a discrete-fracture, submodel with a fracture geometry similar to that envisioned for the continuum model. In practice, the domain for the discrete model would be much smaller in size and contain many fewer intersections than the continuum model. By comparing breakthrough curves for discrete models and continuum models of the same system the authors have been able to demonstrate the validity and usefulness of this modeling procedure. The application of this approach included here is used to illustrate the potential applicability of the approach to a much larger two-dimensional system. 6 references, 6 figures.

20087 (DOE/ER/60152—1-Pt.2, pp 547-561) **Hydrogeology of rocks of low permeability: region studies.** Llamas, M.R. (Autonomous Univ., Madrid, Spain). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Hydrogeological regional studies on low permeability rocks are rather scarce in comparison to similar studies on normal permeability rocks. Economic and technological difficulties to develop ground water from these terrains may be the main cause of this scarcity. Several facts may indicate that these studies will increase in the near future. First, the need to supply water to the people living in underdeveloped arid zones over extensive areas of low permeability rocks. Second, the relevant role that some low permeability large groundwater basins may play in conjunctive ground and surface-water use. And last but not least the feasibility of some low permeability rock areas as sites for nuclear waste repositories. Some specific difficulties in these regional studies may be: a) intrinsic difficulties in obtaining representative water samples and measuring hydraulic heads; b) scarcity of observation and/or pumping wells; c) important hydraulic head and chemical properties variations in a vertical direction; d) old groundwater ages; this may require paleohydrological considerations to understand certain apparent anomalies. In most of these regional studies hydrogeochemical methods and modelling (flow and mass transport) may be very valuable tools. 77 references, 7 figures.

20088 (DOE/ER/60152—1-Pt.2, pp 562-573) **Low permeability volcanics in the Canary Islands (Spain).** Custodio, E. (UPC-ETSIIB, Barcelona, Spain). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The Canary Islands, about 2000 km to the SW of continental Spain, are fully volcanic, from mid Miocene to recent. The permeability of the formations depends very much on the age and lithology. In most instances young, pervious basalts are devoid of water due to their altitude and most water abstraction works must go into the underlaying, much less pervious, older formations. Long water galleries or large diameter wells fitted with a crown of horizontal bores are able to catch significant quantities of water from formations which permeability is less than 0.1 m/day. The anisotropic behavior of the formations, specially due to the injection of subvertical dykes parallel to the coast, explains the high hydraulic gradient found, up to 0.15, and the relative high yield of the wells and galleries. The specific yield of the volcanics is fairly high, about 0.02 to 0.05, thus allowing the use of reserves to supply the demand. Conventional finite-difference models give a sound picture of the groundwater behavior but preliminary adjustments of the hydraulic parameters need the study of simplified cross-sections. The study of the chemical characteristics of groundwater is a key factor in the understanding of groundwater flow. The discussion refers mainly to Lanzarote, Tenerife and Gran Canaria Islands, but some comment will use information from other islands. 23 references, 10 figures, 2 tables.

20089 (DOE/ER/60152—1-Pt.2, pp 574-584) **Flow, origin, and age of groundwater in some deep-lying poorly permeable aquifers in the Netherlands; implications for geological waste disposal.** Glasbergen, P. (Soil and Groundwater Research Lab., Leidschendam, Netherlands). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Interest in the hydrological properties of deep strata has been increasing rapidly, especially in relation to waste disposal. For the assessment of the geohydrological stability of the host-rock itself as well as of the migration of contaminants leached from a disposal facility, investigation of the hydrological system is obligatory. Three drillings down to and beyond 500 m through very thick clay layers yielded a number of data providing new information about the hydrological system of deep strata in the Netherlands. Clay samples were taken profiles of water quality vs. depth were established, and groundwater present above and below the deep clay strata was subjected to chemical analyses in isotope determinations. Well tests and slug tests were performed to determine the permeability of the underlying aquifers. Hydraulic conductivity was found to range from $10^{-7}$ to $10^{-6}$ m/s. The estimated age of the deep groundwater below the Oligocene clay is at most about 4 x $10^{4}$ years. An interpretation of the flow system is given on the basis of the relations found between water quality, depth, the conductivity, and the measured water pressures. The present observations and interpretations lead to the conclusion that the groundwater in the investigated deep strata is part of a hydrological cycle whose scale is probably limited and in some places very limited. Studies based on a model support the presented conclusions. 18 references, 9 figures.

20090 (DOE/ER/60152—1-Pt.2, pp 596-611) **Hydrodynamics of aquifers and aquitards at proposed high-level nuclear-waste repository sites, Palo Duro Basin, Texas, USA.** Bair, E.S.; O'Donnell, T.P. (Stone & Webster Engineering Corp., Cherry Hill, NJ). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Bedded salt in the Palo Duro Basin area of the Texas Panhandle is being evaluated as possible host rock for a high-level nuclear-waste repository. The two proposed sites are underlain by three major hydrostratigraphic units: an 800- to 1100-foot thick freshwater aquifer system, a 4100- to 4700-foot thick shale and evaporite aquitard that contains the target salt horizon, and a 2800- to 4400-foot thick deep-basin brine aquifer system. Water in the Ogallala/Dockum freshwater aquifer system overlying the host rock predominantly flow horizontally and discharges to springs and wells. However, the equipotential pattern on a potentiometric profile based on equivalent freshwater heads indicates that some water may be moving downward across the shale and evaporite aquitard and into the deep-basin aquifer systems. The potentiometric profile also indicates that near the eastern caprock escarpment water may be moving upward within the upper part of the shale and evaporite aquitard. Equipotential patterns in the Wolfcamp and Pennsylvanian aquifers, the major regionally important down gradient deep-basin aquifers underlying the host rock, are influenced by permeability variations related to facies changes. Hydraulic gradients are flatter in the more permeable shelf, shelf margin, and fan delta facies, and steep in the less permeable deep-basin facies. 18 references, 13 figures.

20091 (DOE/ER/60152—1-Pt.2, pp 612-621) **Relationships of flow in crystalline rock aquifers: a solution to the fracture problem.** Atobrah, K. (Geraghty & Miller, Inc., Syosset, NY). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The so-called fracture problem in analyzing flow in crystalline rock aquifers persists because of both the lack of critical obser-

vations of field information and a biased influence from the porous media theory. The inconsistencies in the analysis of data give cause to re-evaluate the double porosity model which assumes that the transfer of fluid from blocks to fissures can be described by pseudo-steady state flow, and the fissure block model which assumes that the transfer of fluid from blocks to fissures occurs under fully transient conditions. It is suggested that these model approaches that duel on porosity concepts should be re-evaluated in terms of the behavior of the flow which is related to the exact functions of the fractured medium, and therefore, unrestricted by the kind of porosity present. Observations of pumping tests in fractured aquifers provide practical demonstrations that, basically, two flow relationships may exist in a porous fractured medium with a possible transition between the two as a result of fracture skin effects. The two flow relationships are fast flow that is defined physically by a relatively large representative elementary volume with flow in predominant fracture zones and having a set of pump test data that fits the latter-time curvilinear part of the time-drawdown curve, and a slow flow that is representative of the linear relationship of the early-time drawdown curve in the fractures at the vicinity of the well. 28 references, 3 figures.

20092 (DOE/ER/60152—1-Pt.2, pp 622-630) **Evaluation of transmissivity of Deccan Basalts of Maharashtra, India, using aquifer response from large diameter dugwells.** Deolankar, S.B.; Kulkarni, H.C. (Univ. of Poona, India). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

In the Deccan Basaltic area of Maharashtra, India the weathered basalts and the fractured-jointed basalts form the major, shallow unconfined aquifers. The groundwater is exploited by means of large-diameter dugwells. It has been observed that only a small portion of the total aquifer surface area tapped by the dugwell contributes to the inflow into the well e.g. through interflow zones, through a few joints etc. Further the pump discharge (Q/sub p/) in $m^3$/minute from the dugwell consists of aquifer response (Q/sub a/) in $m^3$/minute and water derived from the storage (Q/sub s/) in $m^3$/minute. Q/sub a/ increases with time and drawdown. Q/sub a/ and Q/sub s/, both have an effect on the drawdown. The drawdown data is generally analyzed by using the pump discharge with Cooper-Jacob (1946) and Papadopulos-Cooper (1967) methods. The values of transmissivity calculated by these methods appear to be on the higher side. This is particularly apparent in light of the partial contribution from total aquifer surface area tapped by the well and the slow rate of inflow into the well. The values of transmissivity will be more realistic if the effect of Q/sub a/ on drawdown is used in the Cooper-Jacob formula. The methods used for calculating the transmissivity value is discussed. 11 references, 3 figures, 3 tables.

20093 (DOE/ER/60152—1-Pt.2, pp 793) **Strategy and sequencing of hydrologic characterization of the Columbia River basalts.** Leonhart, L.S.; Lu, A.H.; Baker, S.M. (Rockwell Hanford Operations, Richland, WA). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Development of strategy to provide specific information on a geologic medium, for which the conceptual hydrologic system is, initially, unknown or poorly understood, requires thoughtful planning and sequencing of tests. In southeastern Washington, the sponsorship of the National Waste Terminal Storage Program (of the US Department of Energy) has provided a significant opportunity to further the conceptual understanding of Columbia River basalts hydrology. The Basalt Waste Isolation Project has prepared a strategy for field characterization of the basalts which involves four major phases of field investigation; reconnaissance investigations, hydraulic head baselining, large-scale hydraulic testing, and underground tests. The paper will provide a brief description of the type and purpose of the investigations associated with each phase and the general rational underlying the approach to these hydrologic characterization activities. In particular, the manner by which information from earlier phases of the investigation is used to plan and prepare for later phases is discussed. Examples will be provided which illustrate the data reduction performed on reconnaissance-level transmissivity data, the use of natural transients in hydraulic head to obtained preliminary estimates of hydraulic properties, and the opportunity of using drilling stresses to design large-scale tests and to predict performance.

20094 (DOE/ER/60152—1-Pt.2, pp 795) **Hydraulic studies in low permeability evaporite deposits, southeastern New Mexico, (SENM).** Gonzalez, D.D. (Sandia National Labs., Albuquerque, NM). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

In support of the hydrogeologic characterization of the proposed Water Isolation Pilot Plant (WIPP), in SENM, hydraulic studies in Permian evaporites within the Delaware Basin have been on going since 1975 and were intensified and expanded in 1980. The hydrologic program for WIPP is designed to determine the parameters necessary to model the site area for mass transport considering the limitations imposed by the large areal extent of the study area and range in transmissivity (10E2-10E-3 sq-ft/day), a double medium, fracture-filled system, water quality and density (1.001-1.260 g/cc) variation, and a limited number of test and observation wells. This paper reviews the principal components of the WIPP Hydrology Program.

20095 (DOE/ER/60152—1-Pt.2, pp 797) **Hydrogeological characterization, modelling and monitoring of the site of Canada's Underground Research Laboratory.** Davison, C.C.; Guvanasen, V. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Atomic Energy of Canada Limited (AECL) is constructing an Underground Research Laboratory (URL) to a depth of 250 m in a previously undisturbed granitic pluton located near Lac du Bonnet, Manitoba, as one of the major research projects within the Canadian Nuclear Fuel Waste Management Program. This paper discusses the hydrogeological characterization of the URL site, the modelling approach used to represent this information, the hydrogeological monitoring system installed to monitor the actual drawdown conditions that develop in response to the excavation, and the procedures employed to calibrate the numerical model. Comparisons between the drawdown predictions made by the model prior to any excavation and the actual drawdowns that have been measured since shaft excavation began in May 1984 are also discussed.

20096 (DOE/ER/60152—1-Pt.2, pp 800) **Regional ground-water flow in the crystalline rocks and overlying sedimentary sequence of northern Switzerland.** Kiraly, L.; Kimmeyer, I.F.; Perrochet, P.; Andrews, R.W. (Universite d' Neuchatel, Switzerland). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

In order to evaluate the principal ground-water flow directions and rates from a potential high level waste repository site in northern Switzerland, ground-water models were constructed and tested using a three-dimensional, finite element flow code (Kiraly, 1984). The modeling was conducted as two scales. The regional model extends from the central Alps (south) to the Black Forest (north) and from Lake Constance (east) to the Jura Mountains (west). The local model focuses on flow between the Rhine and Aare Rivers in order to better define the flow in the vicinity of the repository area, as well as to incorporate greater structural, stratigraphic and topographic complexity than is possible in regional model. The results generated from the regional and local model must be tempered by the degree of averaging of hydrologic properties incorporated in the models. The scale of investigation (hundreds to thousands of square kilometers) has necessitated a large spatial averaging of the permeability distribution. While the average permeability may remain uniform over a large distance (kilometers), on a smaller scale the permeability distribution may be quite heterogeneous and individual fractures of the hydrogeologic unit may be

noncontinuous. This implies that the regional scale assessments may not apply on a fine scale. However, they are still appropriate for assessments of regional flow and transport (i.e., from the repository to the biosphere).

20097 (DOE/ER/60152—1-Pt.2, pp 803) **Deep installations of monitoring instrumentation in unsaturated welded tuff.** Tyler, S. (Univ. of Nevada System, Las Vegas). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The major goal of this research is to develop low cost techniques to measure matric potential, moisture content, and to sample liquid and vapor for chemical analysis in the deep unsaturated zones of the arid areas of Nevada. This work has been prompted by the high level waste repository proposed in the unsaturated zone of Yucca Mountain. The work presented focuses on two deep (250 meter) boreholes planned for completion at the southern end of Yucca Mountain in fractured tuff. One borehole will be drilled without water and cased to slightly below the zone of saturation in order to measure the depth to saturation and to collect water samples for analysis. This hole will also be used for routine quarterly neutron logging. Between loggings, vapor liquid water samplers will be suspended in the borehole and packed off at selective screened intervals to collect water vapor for isotopic analysis. The second borehole will be drilled to slightly above the water table and serve as a multiple interval psychrometer installation. Thermocouple psychrometers will be placed in isolated screened intervals within the casing. These boreholes will be used for instrument testing, interference and permeability testing, and to monitor short term fluctuations of soil and rock moisture due to precipitation and recharge.

20098 (DOE/ID/12513—T1) **Disposal of low-level radioactive waste using high-calcium fly ash. Final report.** Cogburn, C.O.; Hodgson, L.M.; Ragland, R.C. (Arkansas Univ., Fayetteville (USA). Dept. of Mechanical Engineering). Apr 1986. Contract FG07-84ID12513. 43p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86015473.

The feasibility of using calcium-rich fly ash from coal-fired power plants in the disposal of low-level radioactive waste was examined. The proposed areas of use were: (1) fly-ash cement as a trench lining material; (2) fly ash as a backfill material; and (3) fly ash as a liquid waste solidifier. The physical properties of fly-ash cement were determined to be adequate for trench liner construction, with compressive strengths attaining greater than 3000 psi. Hydraulic conductivities were determined to be less than that for clay mineral deposits, and were on the order of $10^{-7}$ cm/sec, with some observed values as low as $10^{-9}$ cm/sec. Removal of radioisotopes from acidified solutions by fly ash was good for all elements tested except cesium. The removal of cesium by fly ash was similar to that of montmorillonite clay. The corrosive effects on metals in fly ash environments was determined to be slight, if not non-existent. Coatings at the fly-ash/metal interfaces were observed which appeared to inhibit or diminish corrosion. The study has indicated that high-calcium fly ash appears to offer considerable potential for improved retention of low-level radioactive wastes in shallow land disposal sites. Further tests are needed to determine optimum methods of use. 8 refs., 4 figs., 7 tabs.

20099 (DOE/NBM—7005567) **Radioactive waste management technical cooperation program, 1985-1989: Quarterly report to December 1986.** Simmons, G.R.; Versluis, W.S. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment; Battelle Memorial Inst., Willowbrook, IL (USA). Office of Waste Technology Development). Dec 1986. 23p. (GESD—87-04). NTIS (US Sales Only), PC A02/MF A01; 1; GPO Dep. File Number DE87005567.

The status of the following tasks is reported: cooperative experimental program at URL; performance assessment studies; field testing investigations; and shaft extension and characterization.

20100 (DP—1729) **Investigation of lead-iron-phosphate glass for SRP waste.** Jantzen, C.M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Oct 1986. Contract AC09-76SR00001. 63p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006356.

The search for a host solid for the immobilization of nuclear waste has focused on various vitreous waste forms. Recently, lead-iron-phosphate (LIP) glasses have been proposed for solidification of all types of HLLW. Investigation of this glass for vitrification of SRP waste demonstrated that the phosphate glass is incompatible with the current borosilicate glass technology. The durability of LIP glasses in deionized water was comparable to current borosilicate waste glass formulations, and the LIP glass has a low melt temperature. However, many of the defense waste constituents have low solubility in the phosphate melt, producing an inhomogeneous product. Also, the LIP melt is highly corrosive which prevents the use of current melter materials, in particular Inconel 690, and thus requires more exotic materials of construction such as platinum.

20101 (DP-MS—86-71) **Demonstration of a remotely operated TRU waste size-reduction and material handling process.** Stewart, J.A. III; Schuler, T.F.; Ward, C.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1986. Contract AC09-76SR00001. 8p. (CONF-8611139—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006382.

From Remote handling operations in waste processing, decontamination, and size-reduction facilities conference; Washington, DC, USA (12 Nov 1986).

Noncombustible Pu-238 and Pu-239 waste is generated as a result of normal operation and decommissioning activity at the Savannah River Plant and is being retrievably stored at the site. As part of the long-term plan to process the stored waste and current waste for permanent disposal, a remote size-reduction and material handling process is being tested at Savannah River Laboratory to provide design support for the plant TRU Waste Facility scheduled to be completed in 1993. The process consists of a large, low-speed shredder and material handling system, a remote worktable, a bagless transfer system, and a robotically controlled manipulator, or Telerobot. Initial testing of the shredder and material handling system and a cycle test of the bagless transfer system were completed. Initial Telerobot run-in and system evaluation was completed. User software was evaluated and modified to support complete menu-driven operation. Telerobot prototype size-reduction tooling was designed and successfully tested. Complete nonradioactive testing of the equipment is scheduled to be completed in 1987.

20102 (DP-MS—86-110) **Concept development for saltstone and low level waste disposal.** Wilhite, E.L. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Mar 1987. Contract AC09-76SR00001. 6p. (CONF-870306—28). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006386.

From Waste management '87; Tucson, AZ, USA (1 Mar 1987).

A low-level alkaline salt solution will be a byproduct in the processing of high-level waste at the Savannah River Plant (SRP). This solution will be incorporated into a cement wasteform, saltstone, and placed in surface vaults. Laboratory and field testing and mathematical modeling have demonstrated the predictability of contaminant release from cement wasteforms. Saltstone disposal in surface vaults will meet drinking water standards in shallow groundwater at the disposal area boundary. Planning for new Low-Level Waste (LLW) disposal could incorporate concepts developed for saltstone disposal.

20103 (DP-MS—86-142) **Tank farm processing of high-level waste for the Defense Waste Processing Facility.** d'Entremont, P.D.; Walker, D.D. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Mar 1987. Contract AC09-76SR00001. 6p. (CONF-870306—27). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006388.

From Waste management '87; Tucson, AZ, USA (1 Mar 1987).

The high-level radioactive waste that has accumulated at the Savannah River Plant is stored in large, underground steel tanks. Programs to remove the waste from the storage tanks and immobilize the radioactivity in borosilicate glass in the Defense Waste Processing Facility (DWPF) are currently in the construction phase. Much of the processing of the waste prior to vitrification is accomplished in the waste storage areas (tank farms). Tank farm processing includes resuspension and washing of the insoluble (sludge) waste, dissolution and decontamination of soluble (salt) waste, and waste transfer between the tanks and operations areas. The overall program for handling the waste in the tank farms, the research program that supports it, and the major concerns with implementing the program are described.

20104 **(DP-MS—86-168) Capabilities and modification plans for the Savannah River New Special Recovery facilities.** Gray, L.W.; Molen, G.F.; Lynn, J.M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1986. Contract AC09-76SR00001. 7p. (CONF-8610226—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006381.

From 6. annual plutonium pyrochemical workshop; Los Alamos, NM, USA (7 Oct 1986).

The Savannah River New Special Recovery (NSR) facility is located in the 200-F Separations Area. This facility was designed and constructed to convert easily dissolvable plutonium oxides and metal from both onsite and offsite residues to plutonium nitrate-nitric acid solution. Capabilities were provided to purify a portion of the clarified dissolver solutions via anion exchange. The primary purification is provided by the 221-F canyon solvent extraction system. Minimal capacity was provided to handle slurries from poorly dissolving materials. The Actinide Technology Division of the Savannah River Laboratory is presently engaged in R and D to enhance both the solids throughput of the dissolvers and the feed clarification methods.

20105 **(DP-MS—86-187) Ion exchange processes for clean-up of dilute waste streams by the F/H Effluent Treatment Facility at the Savannah River Plant.** Bibler, J.P.; Wallace, R.M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1987. Contract AC09-76SR00001. 8p. (CONF-870485—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87006380.

From Ion-Ex '87; Wrexham, UK (13 Apr 1987).

The F/H Effluent Treatment Facility will treat dilute waste streams currently diverted to seepage basins at the Savannah River Plant. In November 1988, the seepage basins are scheduled to be retired and the facility will process the streams to remove toxic and radioactive species before they reach the environment. After rigorous filtration and reverse osmosis, cation exchange will be used as a polishing step. Mercury and other non-radioactive heavy metals will be removed on a thiol cation exchange resin that will not be removed using a sulfonic acid resin that will be regenerated. The spent thiol resin will be stored and the solution containing recovered cesium and strontium will be incorporated in concrete for disposal.

20106 **(DPST—86-692) Leaching TC-99 from DWPF glass in simulated geologic repository groundwaters.** Bibler, N.E.; Jurgensen, A.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 30 Sep 1986. Contract AC09-76SR00001. 19p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005770.

The purpose was to determine if DWPF glass in geologic groundwaters would immobilize Tc-99 as well as it does other elements. A previous study (using a borosilicate glass of a very different composition from DWPF glass) indicated that Tc-99 leached rapidly from the glass suggesting that glass may not be a good matrix for immobilizing Tc-99. It was suggested that the Tc-99 had migrated to vesicles in the glass while the glass was still molten. To determine if borosilicate glass was a good immobilizing matrix for Tc-99, this study was performed using DWPF glass. The leaching of Tc-99 was compared to other elements in the glass. It was shown that rapid leaching will not occur with SRP glass. The leach rate for Tc-99 was nearly identical to that for B, a matrix element in the glass. Another objective was to compare the release of Tc-99 under oxidizing and reducing conditions with other elements in the glass. In the tests described here, even though the glass was dissolving more under reducing conditions as a result of abnormally high pH values, less Tc-99 appeared in solution.

20107 **(EUR—10038) Testing and evaluation of solidified high-level waste forms. Joint annual progress report 1983.** Malow, G. (ed.). (Commission of the European Communities, Luxembourg). 1985. 237p. NTIS (US Sales Only), PC A11/MF A01. File Number DE87750991.

A second joint programme of the European Atomic Community was started in 1981 under the indirect action programme (1980-1984), Action No. 5 'Testing and evaluation of the properties of various potential materials for immobilizing high activity waste'. The overall objective of the research is to test various European potential solidified high-level radioactive waste forms so as to predict their behaviour after disposal. The most important aspect is to produce data to calculate the activity release from the waste products under the attack of various aqueous solutions. The experiments were partly performed under waste repository relevant conditions and partly under simplified conditions for investigating basic activity release mechanisms. The topics of the programme were: (I) studies of basic leaching mechanisms; (II) studies of hydrothermal leaching and surface attack of waste glasses; (III) leach test carried out in contact with granite at low water flow rates; (IV) static leach tests with specimen surrounded by canister and backfill materials; (V) specific isotope leach tests in slowly flowing water; (VI) leach test of actinide spiked samples; (VII) leach tests of highly radioactive samples; (VIII) leach tests of alpha radiation stability; (IX) studies of mechanical stability; (X) studies of mineral phases as model compounds and phase relations.

20108 **(GSF—2/86) Simulation of humidity transport in rock salt in a temperature field. Contribution to the study of problems involved in high-level radioactive waste disposal.** Schlich, M. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Braunschweig (Germany, F.R.). Inst. fuer Tieflagerung; Technische Hochschule Aachen (Germany, F.R.)). 1986. 269p. (In German). (GSF-T—228). NTIS (US Sales Only), PC A12/MF A01. File Number DE87751272.

This contribution studies the humidity transport in rock salt heated up above natural temperature, develops the physical models and suitable computer programs. Two temperature field experiments carried out in the Asse mine - i.e. Temperature Experiment 5 (TV5), and US-FRG Brine Migration Test (BMT) - are chosen for simulation, which leads to the selection of a relevant humidity transport model by means of which penetration of humidity into a repository borehole can be assessed. The interpretation of laboratory measurements of humidity release from heated rock salt specimens shows that the only process of relevance to repository conditions is that of humidity adsorption at grain boundaries. The minerals containing hydrate water (such as polyhalite and kieserite) are shown to release significant amounts of humidity only at high temperatures which are not to be expected in nuclear repositories.

20109 **(INIS-mf—10573) Scientific conference proceedings. Session 3. Radiochemical technology.** Bartosek, V. (ed.). (Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia)). 1985. 46p. (In Czech and Slovak). (CONF-8506335—Pt.3). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701488.

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The Radiochemical Technology session met at UJV Rez on June 7, 1985 to hear 13 papers of which 11 were incorporated in INIS. The papers inform of results attained in the field of processing liquid radioactive wastes from nuclear power plants, processing spent nuclear fuel using the fluoride process, of the separation of fission products by dicarbolide extraction, the chemistry of complex uranium compounds, etc. The cooperation of UJV with VUJE and VUCHZ is also dealt with. (E.S.).

20110 (INIS-mf—10573, pp 9-11) **Work by VUCHZ Brno on problems of radioactive waste disposal and the fluoride process for spent fuel reprocessing.** Masek, Z. (Vyzkumny Ustav Chemickych Zarizeni, Brno, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701488. (CONF-8506335—Pt.3).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The conditions are discussed of design and implementation of the bituminization unit for disposal of radioactive wastes from nuclear power plants. A film rotary evaporator with swing vanes was used for liquid wastes and was completed with storage containers. Performance testing was run in non-active conditions. The bituminization method was extended to processing ion exchangers and ash from the incinerator unit. The designed and manufactured equipment was proven in trial operation. In the field of nuclear fuel reprocessing using the fluoride method a number of materials problems were solved, namely as concerns the technology of processing.

20111 (INIS-mf—10573, pp 13-16) **Work by Nuclear Chemistry Department, Comenius University, Bratislava on dicarbolide extraction of fission products from radioactive wastes.** Macasek, F. (Komenskeho Univ., Bratislava, Czechoslovakia. Prirodovedecka Fakulta). 1985. (In Slovak). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701488. (CONF-8506335—Pt.3).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The results are presented of cooperation between the Department of Nuclear Chemistry of the Science Faculty of Comenius University, Bratislava and UJV in the field of processing spent fuel. During their ten years' cooperation the department studied the separation of technetium and palladium from waste solutions by cobalt dicarbolide extraction. Interesting data were obtained in the study of the main products in irradiated solutions of cobalt dicarbolide in mixtures of nitrobenzene with halogenated hydrocarbons. A list is given of published studies dealing with the said problem area. (E.S.).

20112 (INIS-mf—10573, pp 27-28) **Prospects of development for radioactive waste solidification techniques.** Neumann, L.; Napravnik, J.; Vojtech, O. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701488. (CONF-8506335—Pt.3).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The conception is assessed of the plan of scientific and research work for the 8th five year plan, which is based on concrete demands from nuclear power plants and on the volume of funds allocated for the solution of the said problems. In the 8th five year plan, certain solidification processes developed in the previous five year plan will be implemented. A mobile calcination and cementation unit will be installed at the Dukovany nuclear power plant and a unit for the vitrification of chromate wastes will be set up at the A-1 nuclear power plant. New solidification procedures will be developed and the procedures already used will be improved to allow nuclear power plants to select the optimal technology of dealing with various types of nuclear power plant wastes. (E.S.).

20113 (INIS-mf—10573, pp 39-41) **Treatment of waste water from special laundries of nuclear power plants.** Vanura, P. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701488. (CONF-8506335—Pt.3).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

A survey is given of present methods of treating waste waters from special laundries of nuclear power plants, and the development is described of this problem in Czechoslovakia. Variant methods were developed for the disposal of these liquid radioactive wastes, based on precipitation, i.e., on an adsorption-precipitation technology, and were tried in pilot plant operation with model and real waste waters. Further research aimed at the complex optimization of the whole process ranging from washing to the treatment of the waste waters, anticipates the use of new detergents specially developed for washing contaminated laundry.

20114 (INIS-mf—10573, pp 31-33) **Disposal of radioactive wastes from long-term fuel storage at A-1 nuclear power plant.** Vojtech, O.; Alexa, J.; Kepak, F.; Stejskal, J.; Suessmilch, J. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701488. (CONF-8506335—Pt.3).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

Radioactive wastes generated during the liquidation of the spent fuel store of the A-1 nuclear power plant contain a host of components which are not found in the usual medium- or high-level radioactive wastes. The problems of their solidification consist in the incorporation of high concentrations of chromium, uranium, manganese and potassium into glass products while observing the principles ruling the disposal of high-level wastes. UJV has designed the chemical processing of these wastes and is now preparing documents for the project of a processing line. Technological trials are now under way using an experimental line manufactured at UJV.

20115 (INIS-mf—10573, pp 5-7) **Cooperation of Nuclear Power Plant Research Institute and Nuclear Research Institute in disposal of radioactive wastes from nuclear power plants.** Hladky, E. (Vyskumny Ustav Jadrovych Elektrarni, Jaslovske Bohunice, Czechoslovakia). 1985. (In Slovak). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701488. (CONF-8506335—Pt.3).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

Cooperation with UJV was started soon after the establishment of VUJE (Nuclear Power Plant Research Institute). In the 6th five year plan, cooperation was centred on problems related to the disposal of liquid radioactive wastes from nuclear power plants using bituminization. In the 7th five year plan, cooperation was centred on the development of procedures of nuclear wastes solidification and the volume reduction of solid radioactive wastes, and the decontamination of selected components of the primary circuit of a nuclear power plant. (E.S.).

20116 (JAERI-M—86-001) **Development of a evaluation code for radioactive source residing in the vitrification apparatus.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1986. 27p. (In Japanese). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701015.

A code has been newly developed for evaluating radioactive sources in a hot cell. The evaluation code (WADOSE) can calculate the intensity of radioactive sources residing in each vessel or line of the vitrification apparatus which is installed in the No. 2 cell of Waste Safety Testing Facility (WASTEF), according to radiation doses measured for definite points in the cell. The results calculated by the code will be useful for good maintenances of the apparatus and the products. The report described the system of the code and results of the trial runs.

20117 (NTB—85-06) **Exploratory borehole Boettstein: Results of isotopic investigations concerning the hydrogeological characterization of deep groundwaters.** (Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland)). Jan 1985. 283p. (In German). Nagra, Ch-5401 Baden, Switzerland.

In the following report NTB--85-06 the hydrogeological and hydrogeochemical interpretation of the results of isotopic investigations on groundwater samples from the Nagra deep borehole Boettstein are presented. The Nagra deep borehole Boettstein is the first time it has been possible in Switzerland to investigate and to take groundwater samples from deep sedimentary and crystalline aquifer

during drilling. All isotope methods of interest in hydrogeological studies have been applied to investigate these deep groundwaters: / sup 2/H, /sup 3/H, /sup 13/C, /sup 14/C, /sup 18/O in H/sub 2/ O, /sup 18/O in SO/sub 4/, /sup 34/S, /sup 36/Cl, /sup 39/Ar, / sup 85/Kr, /sup 81/Kr, /sup 3/He, /sup 4/He, noble gases, /sup 40/Ar//sup 36/Ar and the isotopes of the uranium and thorium decay series. In addition studies on rock-samples from the drilled core have been carried out as a cross-check for the interpretation of the isotopic results on groundwater samples. Starting from a description of the acceptable limits of contamination of groundwater samples from boreholes for isotope analyses, and the necessary adaptions for sampling on boreholes, the following subjects are treated: description of the basics of each applied method (as far as not already discussed in the report NTB--83-04) and interpretation of the results of each isotope-method for the groundwaters of the different aquifer formations. A synthesis of all results of the different methods, discussed for each aquifer formation is given in the summary chapter. In the final chapter, the conclusions concerning the spatial hydrogeological picture, as far as can be concluded from the results of one borehole, and a first interpretation of the results of the isotopic investigations with the aim to characterise the hydrodynamic flow directions is presented.

20118 **(NTB—85-08) Hydrogeologic testing of crystalline rocks during the NAGRA deep drilling program.** (Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland)). Jan 1985. 209p. NAGRA, Ch-5401 Baden, Switzerland.

The purpose of this report is to document the theoretical basis and practical application of the NAGRA hydrogeologic testing program. The report deals with borehole hydraulic testing methods and interpretations, commencing with the governing flow equations and their application to various test procedures, such as pulse tests, drill stem tests, pumping tests, etc. The theoretical considerations include quantitative assessment of the relative significance of various fluid properties, equipment compliance, borehole pressure history, thermally induced pressure responses and pressure/temperature skin effects. Practical considerations in the test analyses and interpretation are also quantitatively considered. These considerations include: the flow regime conceptualization (e.g., porous media or fractured media), assumptions inherent in the solutions, estimation of reference pressure, estimation of storage coefficient, pre-test pressure and thermal conditions, borehole diameter, measurement scale, radius of influence, fracture orientations, borehole/formation skin effects, fluid properties, equipment accuracy and resolution, equipment compliance, and test procedures. These considerations are illustrated with numerous examples based on the NAGRA program. The report concludes with detailed guidelines for the measurement of formation pressure. The guidelines are designed to provide a decision-making logic basis for the field hydrogeologists responsible for conducting hydraulic tests.

20119 **(NTB—85-13) Stripa Project. Annual report 1984.** (Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland)). Jun 1985. 48p. NAGRA, Ch-5401 Baden, Switzerland.

The Stripa Project is an international project being performed under the sponsorship of the OECD Nuclear Energy Agency (NEA). The Project concerns research related to the disposal of highly radioactive waste into crystalline rock. The Research and Development Division of the Swedish Nuclear Fuel and Waste Management Company (SKB) has been entrusted with the management of the Project, under the direction of representatives from each participating country. The aim of this report is to inform the OECD Nuclear Energy Agency and the participants in the Project about the general progress of work during 1984.

20120 **(NTB—85-15) Database for radionuclide transport in the biosphere: nuclide specific and geographic data for northern Switzerland.** (Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland)). Jan 1985. 47p. NAGRA, Ch-5401 Baden, Switzerland.

The biosphere model is the final link in the chain of radionuclide transport models, used for radiation dose calculations from high-level waste repositories. This report presents the data needed for biosphere calculations and discusses them where necessary. The first part is dedicated to the nuclide specific parameters like distribution coefficients (water - soil), concentration ratios (soil - plant) and distribution factors (for milk, meat, etc.) which are reported in the literature. The second part contains the choice of regions, their division into compartments and the discussion of nutritional habits for man and animals. At the end a theoretical human population for each region is estimated based on the consumption rates and on the yield of agricultural products, assuming an autonomous nutrition.

20121 **(NTB—85-27) Synthesis of recent investigations on corrosion behaviour of radioactive waste glasses.** (Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland)). Mar 1985. 92p. NAGRA, Ch-5401 Baden, Switzerland.

By way of a supplement to an earlier report (NTB 83-01, EIR-Report Nr. 477), work which has appeared in the meantime on the corrosion behaviour of borosilicate glasses as a solidification matrix for high-level radioactive waste has been evaluated. Many works have confirmed that for a particular glass, besides temperature and pH-value, the silicate concentration of the solution exerts the strongest influence on corrosion rate. The effect of silicate can be described in terms of simple reaction kinetic models which provides a more sound basis for prediction of long-term behaviour of glasses than previously existed. Meanwhile, the effects of backfill- and canister-materials and their corrosion products have been given the attention they merit. These materials affect glass corrosion primarily through regulation of silicic acid concentration. A particular finding which is of interest is the strong inhibition of glass corrosion by lead ions. Stationary corrosion rates in the order of magnitude of 10/sup -5/ g/cm/sup 2/center dotd can be derived from long-term corrosion experiments in stagnant water at 90 C. At the envisaged repository temperature of 55 C they will be one to two orders of magnitude less. The effects of radioactive decay on corrosion rate are either very small or not detectable at all. No further new viewpoints have been put forward with regard to a possible thermal re-structuring of glasses under repository conditions: recrystallisation (devitrification) is not to be feared. With regard to future experiments, further work on quantification of the effects of canister- and backfill-materials and experiments with corrosion inhibitors would be of primary interest.

20122 **(NTB—85-32) Radioecological modelling of the biosphere as illustrated by the example of the model area Oberbauenstock.** (Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland)). Jun 1986. 136p. (In German). NAGRA, Ch-5401 Baden, Switzerland.

The biosphere model is the final link in the chain of radionuclide transport models used for radiation dose calculations for nuclear waste repositories. The dispersion of radionuclides from a low- and intermediate-level waste repository in the biosphere and their uptake by man through food pathways is investigated with a compartment model. The relevant biosphere parameters were based on the model site at Oberbauenstock and compiled as a model data set for further use in the biosphere modelling. Nuclide concentrations in the biosphere compartments and foodstuffs as well as annual individual radiation doses are calculated with the computer program BIOSPH. The present report contains a description of the model area and its subdivision into 4 compartments, a compilation of the relevant parameters and the simplifying assumptions that have been made, discussion of mathematical modelling of nuclide transport in the biosphere and of the calculation of the individual radiation doses, a technical description of the computer program BIOSPH and a detailed presentation of the results from the model calculations.

20123 **(NTB—85-35) Some aspects of the use of iron canisters in deep lying repositories for nuclear waste.** (Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland)). Feb 1985. 33p. NAGRA, Ch-5401 Baden, Switzerland.

Iron canisters for high-level nuclear waste embedded in compacted bentonite in deep geologic repositories will corrode forming hydrogen gas. The equilibrium pressure (when corrosion

would stop) has been estimated to be between 500 and 1000 atm. under repository conditions. As this is much higher than the lithostatic pressure (weight of rock overburden) the gas must be allowed to escape before it disrupts the repository. Escape by diffusion alone is not sufficient but recent experiments (Pusch 1984) have demonstrated that the larger pores in the bentonite are blown free of water and let the gas escape before excessive pressure build up. The potential effect of a capillary breaking layer (CBL) has been explored. A fine layer nearest the canister (e.g. quartz sand) would have much lower capillary suction pressures than the bentonite clay. Hydrogen gas formed by corrosion would drive out water from this layer. The gas/water interface would stabilize at the CBL-bentonite interface. The water cannot be driven out of the bentonite (except from the very largest pores) because of the very high suction pressures. When there is no water in contact with the iron, corrosion will slow down considerably. A steady state corrosion rate will be reached. Due to lack of data at present the steady state pressure and corrosion rate cannot be quantified but it is entirely conceivable that it will decrease by several orders of magnitude below that when water is freely available. If this occurs then an additional effect may be expected. As long as the CLB is void of liquid water no radionuclides can escape, even if the canister is penetrated.

20124 **(NTB—85-54) Thermal loading in the near field of repositories for high and intermediate level nuclear waste.** (Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland)). Jul 1986. 117p. NAGRA, Ch-5401 Baden, Switzerland.

The feasibility, the principal features and operational aspects of the two underground nuclear waste repositories Type B and Type C have been analysed in the NAGRA 'Project Gewaehr 1985' study. The near-field thermal calculations performed for this study are described in detail in this report. The calculations, which have been made to ensure that there is at no time a risk of excessive temperatures being reached, account for heat transfer by conduction, convection and radiation. All these mechanisms may be relevant during the first few years after disposal. The high-level wastes considered are reprocessing waste and spent fuel. The heat generating intermediate-level wastes comprise hulls and endcaps, co-precipitation sludges from reprocessing and certain decommissioning wastes. Disposal of heat-generating wastes has been analysed both for the Type B and the Type C repository. Within the present repository concepts, acceptable temperature distributions can be achieved by appropriate disposal plans and configurations.

20125 **(PNL—4897) Effects of tuff waste package components on release from 76-68 simulated waste glass: Final report.** McVay, G.L.; Robinson, G.R. (Pacific Northwest Lab., Richland, WA (USA)). Apr 1984. Contract AC06-76RL01830;AC03-76SF00098. 151p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86010791.

An experimental matrix has been conducted that will allow evaluation of the effects of waste package constituents on the waste form release behavior in a tuff repository environment. Tuff rock and groundwater were used along with 304L, 316, and 1020M ferrous metals to evaluate release from uranium-doped MCC 76-68 simulated waste glass. One of the major findings was that in the absence of 1020M mild steel, tuff rock powder dominates the system. However, when 1020M mild steel is present, it appears to dominate the system. The rock-dominated system results in suppressed glass-water reaction and leaching while the 1020M-dominated system results in enhanced leaching - but the metal effectively scavenges uranium from solution. The 300-series stainless steels play no significant role in affecting glass leaching characteristics. 6 refs., 28 figs., 5 tabs.

20126 **(PNL-SA—14216) Innovative HEPA [high-efficiency particulate air] filter designs to reduce waste generation and simplify waste treatment.** Oma, K.H.; Ross, W.A.; Smith, W.L.; Adams, J.R. (Pacific Northwest Lab., Richland, WA (USA); Mine Safety Appliances Co., Evans City, PA (USA)). Jan 1987. Contract AC06-76RL01830. 10p. (CONF-870306—30). NTIS MF A01; 2; GPO Dep. File Number DE87006435.

From Waste management '87; Tucson, AZ, USA (1 Mar 1987).

The treatment and disposal of spent high-efficiency particulate air (HEPA) filters has presented a problem at some defense production plants and could be a problem at potential future spent-fuel consolidation or fuel reprocessing facilities. During studies of transuranic (TRU) waste treatment options conducted by Pacific Northwest Laboratory, it was concluded that treatment of spent HEPA filters would become easier and less costly if some modifications were made to the present materials of construction and design. This study was undertaken to develop and evaluate alternative materials and innovative designs for HEPA filters, making them more compatible with volume reduction technology. The following treatment options were selected for this study: (1) no treatment; (2) compaction; (3) supercompaction; (4) incinerate and melt; and (5) separate the frame from the media and dispose of the frame as low-level waste, and incinerate and melt the filter media and sealant. Forty HEPA design concepts were identified and evaluated by means of a figure-of-merit methodology for technical performance and an economic evaluation that considered filter fabrication and disposal costs. Results of the study indicate that if improved HEPA designs are combined with volume reduction treatments, the costs of filter disposal can be reduced substantially over the use of standard-flow filter designs with no volume reduction treatment. It is estimated that by combining the new design concepts with waste volume reduction treatments, manufacturing and disposal costs can be reduced by $290 or more per filter if classified as low-level waste (LLW) and up to $23,000 per filter if it is high-activity waste (containing activity greater than class-C LLW) and requires repository disposal.

20127 **(PNL-SA—14279) Quality assurance records system for research and development activities in support of geologic repository programs.** Smith, J.W.; Ryder, D.E. (Pacific Northwest Lab., Richland, WA (USA)). Jan 1987. Contract AC06-76RL01830. 14p. (CONF-870306—29). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006436.

From Waste management '87; Tucson, AZ, USA (1 Mar 1987).

The Pacific Northwest Laboratory (PNL), which is operated by Battelle Memorial Institute for the Department of Energy, is conducting site-specific research for all three candidate sites for the first geologic high-level waste repository, as well as generic research for the second repository. In conjunction with this effort, PNL has developed a quality assurance (QA) program that is applicable to all organizations that are performing research and development (R and D) activities in support of the repository programs. This QA program meets the basic and supplemental requirements of ANSI/ASME NQA-1-1983 and the Nuclear Regulatory Commission (NRC) Review Plan for QA Programs for Site Characterization of High Level Nuclear Waste Repositories. A key part of this program is the handling of QA records that may ultimately support the licensing process for the repository. This paper describes a QA records system that is flexible enough to accommodate several types of research, such as paper studies, test method development, site characterization studies, software development, and hardware design. In addition, the QA records system is acceptable to a variety of sponsors who have licensing concerns. The QA procedures and their relation to the requirements are described. Most important is the discussion on the approaches used to assure that the records are organized such that the user can readily recreate or defend data, conclusions, and recommendations resulting from the research.

20128 **(RHO-BW-CR—154P) Integrated monitored retrievable storage/repository comparative study: Task 5, Engineering study No. 12.** (Kaiser (Raymond) Engineers, Inc., Homer City, PA (USA); Parsons, Brinckerhoff, Quade and Douglas, Inc., Oakland, CA (USA); Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Nov 1985. Contract AC06-77RL01030. 585p. NTIS, PC A25. File Number DE87006472.

The US Department of Energy (DOE) established a monitored retrievable storage (MRS)/repository interface task force to investigate the impact of implementing an integrated radioactive waste management system. The task force was organized into five subtask groups. Subtask 2 among these groups was given responsi-

bility for developing the repository and MRS surface facility design concepts for various scenarios as established by subtask 1. The development of various concepts focused on the impacts on design, operations, cost, licensing, health and safety, and schedule. Other impacts, including transportation, quality assurance, environmental impact, waste acceptance schedule, and fee adequacy, were not considered to be part of this study. The results of the task force investigation will be documented in an MRS needs and feasibility report and in the MRS integration plan. A study was done that compared several specific engineering study cases that integrated the MRS facility, the basalt repository (Repository No. 1), and the crystalline rock repository (Repository No. 2) into a waste management system. These study cases were derived by DOE as representative of the scenarios established by subtask 1. The scope of this study was limited to repository surface facilities. Factors not considered, which affect how the information is used, include: impact on offsite transportation between an MRS and the repository and impact on repository underground facilities. In addition, the cost and schedule data were developed on a comparative basis between engineering study cases. This study is documented in two submittals. This report includes the results, method of calculation, major decisions, assumptions, and logic used for the study. The second submittal contains the backup material and reference data.

20129 **(SAND—86-1679C) Analysis of a multiphase, porous-flow imbibition experiment in fractured volcanic tuff.** Eaton, R.R.; Bixler, N.E. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 18p. (CONF-861220—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003041.

From American Geophysical Union fall meeting; San Francisco, CA, USA (8 Dec 1986).

A sub-meter-scale imbibition experiment has been analyzed using a finite element, multiphase-flow code. In the experiment, an initially dry cylindrical core of fractured volcanic tuff was saturated by contacting the ends with pressurized water. Our model discretely accounts for three primary fractures that may be present in the core, as indicated by measurements of porosity and saturation. We show that vapor transport has a small (less than 5%) effect on the speed of the wetting front. By using experimental results to estimate apparent spatial variations in permeability along the core, good agreement with measured, transient, saturation data was achieved. The sensitivity of predicted transient wetting fronts to permeability data indicates a need for more extensive measurements. We conclude that it will be difficult to characterize an entire repository - where inhomogeneities due to variations in matrix and fracture properties are not well known - solely from the results of sub-meter-scale laboratory testing and deterministic modeling. 16 refs., 8 figs., 1 tab.

20130 **(SAND—86-7177) Preliminary design for a sorbing tracer test in the Culebra dolomite at the H-3 hydropad at the Waste Isolation Pilot Plant (WIPP) site.** Pearson, F.J. Jr.; Kelley, V.A.; Pickens, J.F. (Sandia National Labs., Albuquerque, NM (USA); Intera Technologies, Inc., Austin, TX (USA)). Feb 1987. Contract AC04-76DP00789. 210p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE87006768.

The use of sorbing tracers in a field hydrologic test is a method of estimating the nuclide transport characteristics at one location in the Culebra dolomite at the Waste Isolation Pilot Plant (WIPP) site. The Culebra is considered to be the principal continuous pathway from the site in the event of a breach of the planned nuclear-waste repository. To prepare for such a tracer test, data evaluation and design calculations are necessary to estimate the principal parameters governing solute transport and the quantity and geochemical character of potential tracers. The following report represents the first step in preparing for a sorbing tracer test, namely a preliminary analysis which considers: (1) the selection of the best location for the first test at the WIPP site; (2) an evaluation of a conservative tracer test at the recommended site to provide estimates of the physical solute-transport parameters; (3) a hydrogeochemical and mineralogic characterization of the Culebra dolomite; (4) the rationale and recipe for the tracer-injection solution; (5) the compilation of a list of potential sorbing and conservative tracers; and (6) the identification of other needs before fielding the sorbing tracer test. The appendix to this report contains the thermodynamic data base used to support the geochemical model (PHREEQE) used in this study.

20131 **(SAND—87-0068C) Double-porosity tracer-test analysis for interpretation of the fracture characteristics of a Dolomite formation.** Kelley, V.A.; Pickens, J.F.; Reeves, M.; Beauheim, R.L. (Sandia National Labs., Albuquerque, NM (USA); Intera Technologies, Inc., Austin, TX (USA)). 1987. Contract AC04-76DP00789. 24p. (CONF-870252—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005876.

From Solving ground water problems with models conference; Denver, CO, USA (10 Feb 1987).

Hydraulic and tracer testing studies have been performed as part of the regional hydrologic characterization of the Waste Isolation Pilot Plant (WIPP) site in southeastern New Mexico. The interpretation of hydraulic tests and tracer tests from a number of locations has indicated the importance of the double-porosity concept in the interpretation of both the hydraulic and solute-transport characteristics of the fractured dolomite under study. A convergent-flow tracer test conducted in the Culebra Dolomite Member of the Rustler Formation at the WIPP site was analyzed using a double-porosity flow and transport model. The transport of conservative tracers from each of the tracer-addition wells was simulated using the double-porosity flow and transport model SWIFT II. The simulation model accounts for advective-dispersive transport in the fractures and diffusive transport in the matrix. Calibration of the tracer-breakthrough curves included conducting a sensitivity analysis on the important parameters: diffusion coefficient, tortuosity, matrix porosity, fracture porosity, effective matrix-block size, pumping rate, initial tracer input distribution, and distance between pumping and tracer-addition wells. Calibration of the tracer-breakthrough curves resulted in longitudinal dispersivities from 5 to 10% of the flow path length (well-separation distance), a fracture porosity of 0.002, and effective matrix-block sizes of 0.8 ft to 3.9 ft. Even though these estimates of fracture porosity and effective matrix-block size are specific to the location of the tracer test, they provide an initial estimate on which to base predictions of the regional transport of solutes in the Culebra dolomite.

20132 **(UCRL—15869) DWTF [decontamination and waste treatment facilities] assessment.** Maimoni, A. (Science Applications International Corp., Pleasanton, CA (USA); Lawrence Livermore National Lab., CA (USA)). 6 Oct 1986. Contract W-7405-ENG-48. 26p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006718.

The purpose of this study has been to evaluate the adequacy of present and proposed decontamination and waste treatment facilities (DWTF) at LLNL, to determine the cost effectiveness for proposed improvements, and possible alternatives for accomplishing these improvements. To the extent possible, we have also looked at some of the proposed environmental compliance and cleanup (ECC) projects.

20133 **Material selection for nuclear waste processing facility.** Bickford, D.F.; Corbett, R.A. (E.I. du Pont de Nemours & Co., Inc., Savannah River Lab., Aiken, SC 29808). *Journal of Materials for Energy Systems;* 8: No. 2, 142-149(Sep 1986).

Construction has started on a facility to immobilize high level radioactive waste in borosilicate glass at the Department of Energy's Savannah River Plant. Type 304L stainless steels is generally sufficient for supply tankage and service lines. It is used as the reference material in chemical reprocessing of reactor target and fuel tubes. Type 304L, however, has unacceptable stress corrosion cracking resistance in solutions containing formic acid and chloride. Scouting tests were performed on twelve commercial nickel-based alloys in simulated process solutions containing halides, sulfates, nitrates, mercury, and formic acid. Mercuric ions and halides interact in acidic environments to increase pitting and crevice attack. Alloys with combined chromium plus molybdenum contents greater than 30 pct, that also contain greater than 9 pct molybdenum, were most resistant to pitting and crevice corrosion. Based on this testing, Alloy C-276 has been selected as the reference process equipment material, with INCONEL 690 and ALLCORR selected for specialty areas.

20134 **Volcanic hazard assessment for disposal of high-level radioactive waste.** Crowe, B.M. (Los Alamos National Lab., NM). pp 247-260 of Active tectonics. Washington, DC; National Academy Press (1986).

Volcanic hazards are evaluated through risk assessment, which is a product of probability and consequences. These studies have been completed for a potential waste disposal site in the Nevada Test Site (NTS). Cenozoic volcanism of the NTS region is divided into three distinct episodes. The youngest episode, 3.7 to 0.3 m.y., comprises scattered, monogenetic Strombolian centers of small volume ($<1$ km$^3$). Rates of volcanic activity for the NTS region are estimated to be about $10^{-6}$ event/yr, based on vent counts through time and calculation of rates of magma production. The conditional probability of disruption of the possible waste disposal site at the NTS by basaltic volcanism is bounded by the range of $10^{-8}$ to $10^{-10}$ yr$^{-1}$. Consequences, expressed as radiological release levels, were evaluated by assuming disruption of a repository by basaltic magmas fed along narrow dikes. Limits are placed on the volume of waste material incorporated in magma by analogy to the abundance of lithic fragments in basalt scoria and lava. These consequences would be increased if rising magma encountered water and produced magma/water vapor explosions, which can eject large volumes of country rock. Such a mechanism would be important only if the vapor explosions excavated a crater to repository depths (380 m) - an unlikely event, based on the dimensions of hydrovolcanic craters. The total expected release from disruption of a repository by basaltic magma for a $10^4$-yr period is 1.8 Ci for spent fuel and 1.3 Ci for high-level waste. 34 references.

20135 **Safety assessment of accident radiological releases: a study performed for the conceptual design of a geologic repository at Yucca Mountain, Nevada.** Jackson, J.L.; Gram, H.F.; Ng, H.S.; Pendergrass, A.M.; Pope, M.C. (Sandia National Labs., Albuquerque, NM). *Nuclear Safety;* **26**: No. 4, 477-487(Jul-Aug 1985).

The Nevada Nuclear Waste Storage Investigations Project is conducting studies to determine the suitability of Yucca Mountain as a site for a high-level radioactive-waste repository. In support of the conceptual design, a preliminary analysis identified events that could cause radiological releases from the surface facilities during the operating period. The consequences of the releases, which were modeled as short-duration release plumes dispersed under averaged climatic conditions, were calculated by using the AIRDOS-EPA code as 50-yr integrated dose commitments to the surrounding population. Possible health effects were estimated by using the BEIR III dose-health-effect relationship. In none of the scenarios devised could the health effects in the general public be distinguished from the effects of background radiation. The risk to the general public from each event was also assessed. First-year total-body dose commitments to the maximally exposed member of the public from each event were calculated by using the ALLDOS code conversion factors. All postulated accidents resulted in individual dose commitments lower than the limit of 0.5 rem per accident set by the Nuclear Regulatory Commission.

20136 **Paleohydrologic techniques with environmental applications for siting hazardous waste facilities.** Foley, M.G.; Doesburg, J.M.; Zimmerman, D.A. (Battelle Pacific Northwest Lab., Richland, WA). pp 99-108 of Sedimentology of gravels and conglomerates. Koster, E.H.; Steel, R.J. (eds.). Calgary, Alberta; Canadian Society of Petroleum Geologists (1984).

Facilities for storing hazardous waste on or slightly below the Earth's surface must be located or designed to avoid disruption of the containment system and dispersal of the wastes by the maximum credible flood in their vicinity. Paleohydrologic techniques, based commonly on data derived from the geometry and sedimentology of alluvial gravels, allow the extension of the historical record into the Holocene and late Pleistocene. This method, unlike statistical manipulations of the historical hydrologic record, includes the manifested effects of the range of past climates on floods in the specific drainage basin. Properly interpreted, including estimation of the span of the paleohydrologic record compared to the desired containment period and the physical relation between processes leading to past extreme floods and future ones, paleohydrology is a valuable asset for aiding the assessment or design of a near-surface storage site for hazardous waste. Paleohydrologic methods are based on the mechanics of flow and sediment transport in alluvial streams. The governing equations relate the flow width, depth, slope, and discharge, and the maximum size of sediment transported. Different techniques are subject to varying degrees of uncertainty, but generally the most reliable estimates can be made for paleoflow surface elevation or depth, followed by width, and then slope with least reliability. Multiple, independent approaches are desirable where adequate data are available; confidence in a paleoflow estimate is increased if different approaches give similar results. Combined methods produce the least uncertainty, but data are seldom adequate to allow their use. 49 references, 2 figures.

## 0530 Environmental Aspects

*REFER ALSO TO CITATION(S) 20090, 20120, 20125, 20130, 20139, 21137, 21240, 21242*

20137 **(DOE/EIS—0117D) Remedial action at the Weldon Spring site: Draft Environmental Impact Statement.** (USDOE Assistant Secretary for Nuclear Energy, Washington, DC. Office of Remedial Action and Waste Technology). Feb 1987. 476p. NTIS, PC A21/MF A01; 1; GPO Dep. File Number DE87006155.

Several alternatives are considered for long-term management of wastes associated with remedial action activities at the Weldon Spring site, located about 48 km (30 mi) west of St. Louis, Missouri. The site is currently contaminated as the result of processing of uranium, thorium, and other materials previously carried out at the site. The Weldon Spring site consists of four areas: raffinate pits, quarry, chemical plant, and vicinity properties. The alternatives considered are: (1) long-term management in the existing raffinate pits with improved containment; (2) long-term management in the raffinate pits area in a new disposal cell (DOE's preferred alternative); (3) long-term management at another site; and (4) no action. Several subalternatives are considered for Alternatives 2 and 3 to more fully explore potential environmental impacts. The potential geological, hydrological, radiological, chemical, ecological, air quality, land-use, and socioeconomic impacts associated with each alternative are assessed and compared for the remedial action period and for long-term management. These analyses indicate that all action alternatives (in particular Alternative 2 - DOE's preferred alternative) can be implemented without significant environmental consequences provided that appropriate mitigative measures are taken.

20138 **(PNL—6112) An overview of the geochemical code MINTEQ: Applications to performance assessment for low-level wastes.** Peterson, S.R.; Opitz, B.E.; Graham, M.J.; Eary, L.E. (Pacific Northwest Lab., Richland, WA (USA)). Mar 1987. Contract AC06-76RL01830. 41p. NTIS, PC A03/MF A01. File Number DE87006590.

The MINTEQ geochemical computer code, developed at the Pacific Northwest Laboratory (PNL), integrates many of the capabilities of its two immediate predecessors, MINEQL and WATEQ3. The MINTEQ code will be used in the Special Waste Form Lysimeters-Arid program to perform the calculations necessary to simulate (model) the contact of low-level waste solutions with heterogeneous sediments of the interaction of ground water with solidified low-level wastes. The code can calculate ion speciation/solubilitya, adsorption, oxidation-reduction, gas phase equilibria, and precipitation/dissolution of solid phases. Under the Special Waste Form Lysimeters-Arid program, the composition of effluents (leachates) from column and batch experiments, using laboratory-scale waste forms, will be used to develop a geochemical model of the interaction of ground water with commercial, solidified low-level wastes. The wastes being evaluated include power-reactor waste streams that have been solidified in cement, vinyl ester-styrene, and bitumen. The thermodynamic database for the code was upgraded preparatory to performing the geochemical modeling. Thermodynamic data for solid phases and aqueous species containing Sb, Ce, Cs, or Co were added to the MINTEQ database. The need to add these data was identified from the characterization of the waste streams. The geochemical model developed from the laboratory data will then be applied to predict the release from a field-

lysimeter facility that contains full-scale waste samples. The contaminant concentrations migrating from the waste forms predicted using MINTEQ will be compared to the long-term lysimeter data. This comparison will constitute a partial field validation of the geochemical model.

## 0540 Health And Safety

*REFER ALSO TO CITATION(S) 20137, 21203*

20139 **(NUREG/CR—4736) Combustion aerosols formed during burning of radioactively contaminated materials: Experimental results.** Halverson, M.A.; Ballinger, M.Y.; Dennis, G.W. (Pacific Northwest Lab., Richland, WA (USA); Nuclear Regulatory Commission, Washington, DC (USA). Div. of Fuel Cycle and Material Safety). Mar 1987. Contract AC06-76RL01830. 48p. (PNL—5999). NTIS, PC A03/MF A01. File Number TI87006796.

Safety assessments and environmental impact statements for nuclear fuel cycle facilities require an estimate of potential airborne releases. Radioactive aerosols generated by fires were investigated in experiments in which combustible solids and liquids were contaminated with radioactive materials and burned. Uranium in powder and liquid form was used to contaminate five fuel types: polychloroprene, polystyrene, polymethylmethacrylate, cellulose, and a mixture of 30% tributylphosphate (TBP) in kerosene. Heat flux, oxygen concentration, air flow, contaminant concentration, and type of ignition were varied in the experiments. The highest release (7.1 wt %) came from burning TBP/kerosene over contaminated nitric acid. Burning cellulose contaminated with uranyl nitrate hexahydrate liquid gave the lowest release (0.01 wt %). Rate of release and particle size distribution of airborne radioactive particles were highly dependent on the type of fuel burned.

20140 **(PNL-SA—14615) Radiation doses for a transportation system and its interface operations for commercial spent fuel.** Schneider, K.J.; Smith, R.I. (Pacific Northwest Lab., Richland, WA (USA)). Feb 1987. Contract AC06-76RL01830. 7p. (CONF-870306—36). NTIS MF A01; 2; GPO Dep. File Number DE87006432.

From Waste management '87; Tucson, AZ, USA (1 Mar 1987).

This paper gives the results of estimates of aggregated radiation doses to the affected public and workers associated with loading spent fuel at the reactors, transporting the spent fuel by truck and rail, and receiving and unloading the spent fuel at a deep geological repository. The estimates are for a postulated transportation-related system using current state-of-the-art technology, if employed in the high-level waste management system in the future, and the approximate dose reduction from some potential system improvements. The results of the study provide a starting point for the US Department of Energy (DOE) to develop an improved transportation system that is cost effective, safe, and results in low radiation doses.

## 0550 Safeguards, Inspection, And Accountability

*REFER ALSO TO CITATION(S) 21005*

20141 **(EUR—10242) VAK III. Seals and sealing system.** d'Agraives, B.C.; Dal Cero, G.; Debeir, R.; Mascetti, E.; Toornvliet, J.; Volcan, A. (Commission of the European Communities, Ispra (Italy). Joint Research Centre; Commission of the European Communities, Luxembourg). 1986. 130p. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751011.

This report presents the VAK III seals and sealing system, which have been used over a period of two years at the Kahl nuclear facility (Federal Republic of Germany), where field tests and feasibility studies were conducted in order to offer a possible solution for the sealing of LWR fuel assemblies. It has been prepared with the aim of an assessment study to be done at the IAEA. It gives all characteristics and technical descriptions for: the sealing principle, the seal construction, the operating tools, the data processing, the drawings, the publications related to that seal. The main points of progress are: the Strong Random Internal Defects (STRID) incorporated in the seals, allowing the obtention of a good signature stability; the Integrity Check on the Seal Status (broken or not) obtained through a decisive mechanical improvement: the Double Breakage Integrity Check (DOBRIC) and with a better ultrasonic evidence of that status; the provision of new function tools, allowing the performance of Identity Measurements in dry conditions (which means also at the manufacturer plant) or in deeper water (wet storage); the study and development of a new JRC VAK 45 Compact Instrument Box, in which all the measuring functions can be grouped and incorporating an autonomous Minicomputer offering to the Inspection the possibility of performing, on the spot, Correlation and Decision processes. The general benefit of such a feasibility study should be to convince the potential users that such a Safeguards Sealing System can be studied for slightly - or largely - different other applications, provided that the Basic and Operating Functions required to the system be clearly defined, possibly after a common agreement would be stated.

20142 **(IAEA-R—3629-F) Fuel assembly identification by magnetic scanning. Final report for the period 1 November 1983-31 October 1985.** (International Atomic Energy Agency, Vienna (Austria)). Sep 1986. 82p. NTIS (US Sales Only), PC A05/MF A01. File Number DE87700887.

In order to identify individual fuel assemblies by a magnetic fingerprint, investigations were made on iron inclusions in fuel elements and a method was developed to measure these by magnetically scanning the element. The fuel assembly is drawn with constant speed through a homogeneous magnetic field to magnetize iron inclusions. Resulting inhomogeneous magnetic dipole fields induce a voltage difference in pick up coils which is proportional to the mass of the inclusion. Using lock-in technique 3 mg pieces of steel wire on the surface of the fuel element were detected while the lower limit for the center of an assembly for ferromagnetic spheres was 50 mg. In single rods ferromagnetic samples of 1 mg were detected regardless of geometric form or location. With minor modifications of the measuring procedure the sensitivity limit can be improved to about 10 mg at the center of an assembly. In the KWU-fuel at Zwentendorf no iron inclusions were found. 13 refs, 57 figs.

20143 (INIS-mf—10574, pp 77-78) **Analytical methods used for nuclear safeguard purposes.** Lukavsky, J. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A05/MF A01. File Number DE87701448. (CONF-8506335—Pt.4).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The quantities are discussed of nuclear materials which are significant with respect to safeguards, and the times are shown necessary for their conversion to nuclear weapons. The detection time and statistical selection of samples for analytical testing are discussed, and the role is characterized of the Central Testing Laboratory of UJV.

20144 **(LA—10827-MS) Neutron collar calibration for assay of LWR [light-water reactor] fuel assemblies.** Menlove, H.O.; Pieper, J.E. (Los Alamos National Lab., NM (USA)). Mar 1987. Contract W-7405-ENG-36. 74p. (ISPO—258). NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006303.

The neutron-coincidence collar is used for the verification of the uranium content in light-water reactor fuel assemblies. An AmLi neutron source is used to give an active interrogation of the fuel assembly to measure the $^{235}U$ content, and the $^{235}U$ content is verified from a passive neutron-coincidence measurement. This report gives the collar calibration data of pressurized-water reactor and boiling-water reactor fuel assemblies. Calibration curves and correction factors are presented for neutron absorbers (burnable poisons) and different fuel assembly sizes. The data were collected at Exxon Nuclear, Franco-Belge de Fabrication de Combustibles, ASEA-Atom, and other nuclear fuel fabrication facilities.

20145 (LA—10838) **International safeguards for a modern MOX [mixed-oxide] fuel fabrication facility.** Pillay, K.K.S.; Stirpe, D.; Picard, R.R. (Los Alamos National Lab., NM (USA)). Mar 1987. Contract W-7405-ENG-36. 74p. NTIS, PC A04/MF A01. File Number DE87006320.

Bulk-handling facilities that process plutonium for commercial fuel cycles offer considerable challenges to nuclear materials safeguards. Modern fuel fabrication facilities that handle mixed oxides of plutonium and uranium (MOX) often have large inventories of special nuclear materials in their process lines and in storage areas for feed and product materials. In addition, the remote automated processing prevalent at new MOX facilities, which is necessary to minimize radiation exposures to personnel, tends to limit access for measurements and inspections. The facility design considered in this study incorporates all these features as well as state-of-the-art measurement technologies for materials accounting. Key elements of International Atomic Energy Agency (IAEA) safeguards for such a fuel-cycle facility have been identified in this report, and several issues of primary importance to materials accountancy and IAEA verifications have been examined. We have calculated detection sensitivities for abrupt and protracted diversions of plutonium assuming a single materials balance area for all processing areas. To help achieve optimal use of limited IAEA inspection resources, we have calculated sampling plans for attributes/variables verification. In addition, we have demonstrated the usefulness of calculating $\sigma$/ sub (MUF-D)/ and detection probabilities corresponding to specified material-loss scenarios and resource allocations. The data developed and the analyses performed during this study can assist both the facility operator and the IAEA in formulating necessary safeguards approaches and verification procedures to implement international safeguards for special nuclear materials.

20146 (RFP—4091) **Are statistics important to safeguards?.** Ferris, Y. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). Mar 1987. Contract AC04-76DP03533. 8p. (CONF-870381—1). NTIS MF A01; 2; GPO Dep. File Number DE87005657.

From Symposium on safeguards at Los Alamos: 20 years; Los Alamos, NM, USA (5 Mar 1987).

The utilization of statistics in safeguards is discussed.

# 07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

20147 (DOE/OR/21400—T293) **Isotope distribution program at the Oak Ridge National Laboratory with emphasis on medical isotopes.** Adair, H.L. (Oak Ridge National Lab., TN (USA)). 26 Feb 1987. Contract AC05-84OR21400. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006617.

The Isotope Distribution Program (IDP) is a group of individual activities with separate and diverse DOE sponsors which share the common mission of the production and distribution of isotope products and the performance of isotope-related services. Its basic mission is to provide isotope products and associated services to the user community by utilizing government-owned facilities that are excess to the primary mission of the DOE. The IDP is in its 41st year of operation. Initially, the program provided research quantities of radioactive materials, and through the 1950's it was the major supplier of radioisotopes for both research and commercial application. Distribution of enriched stable isotopes began in 1954. This paper discusses the use of radioisotopes in medicine and the role that ORNL plays in this field.

## 0701 Physical Isotope Separation

*REFER ALSO TO CITATION(S) 20410*

20148 (IA—1421, pp 189) **Imaging properties of a convex spherical surface emitting a space charge limited ion current.** Chavet, I. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20149 (INIS-mf—10574, pp 41-44) **Radionuclide generators for medical applications.** Budsky, F.; Kopecka, B.; Prokop, J.; Sistek, I. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A05/MF A01. File Number DE87701448. (CONF-8506335—Pt.4).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The principles are briefly outlined of short-lived radionuclide generators, including the preparation of the mother radionuclide, chemical properties and the possible applications in nuclear medicine. Basic physical characteristics (type and half-life of decay and gamma quantum energies), possible production reactions and separation principles are listed for 7 genetic radionuclide pairs of prospective generators. Currently, UJV manufactures /sup 99m/Tc and /sup 113m/In generators for medical applications. (B.S.).

## 0702 Radiation Sources

20150 (IA—1421, pp 159) **New type of Mo-99/Tc-99m generator system.** Ringler, G.; Shrem, S.; Zauber, H. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20151 (IA—1421, pp 159-160) **Wet column radiolysis.** Ringler, G.; Shrem, S.; Zauber, H. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20152 (IA—1421, pp 160) **Mo-99/Tc-99m generator. Column performance.** Ringler, G.; Shrem, S.; Zauber, H. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20153 (IA—1421, pp 190-191) **New ion source for separation of rare-earth isotopes.** Hevron, E.; Engler, G. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20154 (IA—1421, pp 197) **Use of HgI/sub 2/ solid state detector in gamma-ray densimetry.** Pasi, M.; Shahal, O.; Matmor, A. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20155 (IA—1421, pp 198-199) **Contact-free nuclear continuous volume-gauge based on neutron scattering.** Pasi, M.; Piestun, S.; Caras, I. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20156 (IA—1421, pp 199-200) **Automatic system for measuring the level of low density gun powder in fully assembled bullets.** Eisen, Y.; Kedem, D.; Izak, E.; Yellin, E. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20157 (IA—1421, pp 189-190) **Enhanced adhesion of thin films by the ion mixing facility in the electromagnetic isotope separator MEIRA.** Chavet, I.; Lempert, G. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

**20158** (INIS-SU—392, pp 563) **Reference X-ray sources based on radionuclides.** Aristov, E.A.; Bazhenov, V.A.; Bakhshi-Zade, V.A. 1986. (In Russian). NTIS (US Sales Only), PC A99/MF A01. File Number DE87780053. (CONF-8604278—Summs.).

From 36. conference on nuclear spectroscopy and nuclear structure; Khar'kov, USSR (15 Apr 1986).

**20159** **(PPA-T—15.1) Report on the extent of radioisotope usage in Malaysia.** (Unit Tenaga Nuklear, Bangi, Selangor (Malaysia)). Apr 1983. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701489.

A market survey was carried out to study the extent of radioisotope usage in Malaysia. From the survey, the radioisotopes and their activities/quantities that are used in Industry, Medicine and Research were identified. The radioisotopes that are frequently needed or routinely used were also determined and this formed the basis of the recommendations put forward in this report. It is proposed that PUSPATI adopt the concept of a Distribution Centre in order to provide a service to the Malaysian community.

# 08 HYDROGEN

## 0801 Production

*REFER ALSO TO CITATION(S) 19902*

**20160** **(PB—87-144333/XAB) Solar-fuel synthesis based on colloidal and particulate semiconductors. Annual report (3rd) August 1, 1985-July 31, 1986.** Frank, A.J.; Graetzel, M. (Solar Energy Research Inst., Golden, CO (USA)). 1986. 72p. NTIS, PC A04/MF A01.

See also report dated 15 Aug 85, PB86-132826.

A new molecular water-oxidation catalyst that exhibits good durability and high activity is discussed. The catalyst is an oxo-bridged ruthenium dimer with 5,5'-dicarboxy-2,2'-bipyridyl ligands. The dimer is generated in situ from cis-RuL2($OH_2$)$_3$. Mechanistic information has been obtained on $H_2$ production from water with ($Pt(bpy)_3$)($Pt(CN)_4$) and the $H_2$ yield has been improved substantially. New linear chain compounds, having improved characteristics, were synthesized. Charged interfaces in colloidal semiconductor systems with appropriate electron relays improve dramatically charge separation and photosensitized $H_2$ evolution from water. The activity of surface-modified anatase particles was tested for water-splitting in a solar reactor. The activity of a new rhenium-based catalyst largely exceeds that of other noble metals commonly used to promote the photocleavage of $H_2S$. The activity of a tungstosilicic acid coating is found to be comparable to that of Pt for $H_2$ production.

## 0802 Storage

**20161** **(ORNL/TM—8982) Heat transfer in iron-titanium hydride beds.** Lin, T.H.; Watson, J.S. (Oak Ridge National Lab., TN (USA)). Jan 1987. Contract AC05-84OR21400. 171p. NTIS, PC A08/MF A01. File Number DE87005298.

New data on the thermal conductivity of FeTi hydride under hydrogen pressure were obtained and were found to be inversely related to absolute temperature. Compared to previous results, their dependence on hydrogen pressure is considered more reliable and should be used in modeling studies to predict the behavior of hydride beds. Results show that activation (conditioning) of the FeTi hydride is necessary before a practical reaction rate can be obtained since there is no indication of reaction between hydrogen and FeTi hydride not previously activated even at a pressure of 500 psig hydrogen. According to experimental data and a mathematical model, the addition of aluminum in a reticulated open-cell form does benefit the reaction in the hydride bed, and heat transfer improvement is a strong function of the form of the aluminum. Smaller cell sizes give faster hydrogen charging/discharging rates. The aluminum content and cell size in the Al-enhanced hydride bed determine (1) the expected rate, and (2) the amount of hydrogen to be charged/discharged. For more detailed design purposes, the model developed in this report can be used to assess bed performance. 43 refs., 33 figs., 5 tabs.

## 0808 Properties

**20162** **Laminar flame propagation in premixed gases.** Westbrook, C.K.; Miller, J.A. New York, NY; Gordon and Breach Science Publishers Inc. (1984). 365p. Gordon and Breach Science Publishers Inc., P.O. Box 786, Cooper Station, New York, NY 10276.

This book presents the latest advances and techniques in modeling-from boundary methods to asymptotic methods-as well as the applications of these models to problems of flame stability, ignition and quenching. Topics considered include spherically symmetric flame propagation in hydrogen-air mixtures; transport algorithms for methane flames; kinetic modeling of the oxidation of ammonia in flames; stochastic calculation of laminar wrinkled flame propagation via vortex dynamics; a computational study of ignition by oxygen dissociation; and the effect of pressure variations on premixed flames.

# 09 OTHER SYNTHETIC AND NATURAL FUELS

## 0901 Hydrocarbon Fuels

*REFER ALSO TO CITATION(S) 20162, 20808*

**20163** **Initial behavior of a reduced fused-magnetite catalyst in the Fischer-Tropsch synthesis.** Satterfield, C.N.; Hanlon, R.T.; Tung, S.E.; Zou, Z.M.; Papaefthymiou, G.C. (Dept. of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA). *Industrial and Engineering Chemistry, Product Research and Development;* **25**: No. 3, 401-407(Sep 1986).

In studies at 232 and 248°C and 0.92 MPa, during the first 20 h on stream, both Fischer-Tropsch synthesis activity and CO consumption increased to quasi-steady-state values. The bulk catalyst, initially α-Fe, was converted to a mixture of α-Fe and iron carbides, as determined by Mossbauer spectroscopy. During the first few hours, methane selectivity decreased markedly while the olefin/paraffin ratio increased. No change was observed in the C/ sub 2/-C/sub 8/ product distribution with time on stream.

## 0902 Alcohol Fuels

**20164** **(DOE/PC/70022—T4) Optimum higher alcohol mixtures for fuels from syngas: Technical progress report, July-September 1986.** (Union Carbide Corp., South Charleston, WV (USA). Research and Development Dept.). 27 Oct 1986. Contract AC22-84PC70022. 48p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005640.

The objective is to develop and evaluate novel homogeneous catalytic systems for the selective conversion of low $H_2$/CO-ratio syngas to alcohol fuel extenders. Under Task I, screening of several types of additives with ruthenium catalyst systems has continued. The basic objective of this effort is to modify the catalyst systems so that higher alcohols can be produced directly from syngas. Efforts are therefore directed toward increasing the total activity of the systems so that a lower operating pressure can be realized. At the same time, studies are being directed toward increasing the $C_2$+ alcohol selectivity of the systems. For task III, further investigations have been carried out in an effort to gain basic information on the catalytic chemistry involved in the novel methanol homologation system. Earlier work in this project has shown the importance of specific catalyst additives in the new homologation system. Further work has now been carried out on additives similar to one of these, A25, both to learn about the essential characteristics of this additive and to try to further enhance the rate and selectivity with a different additive. Several more additives of this type have

now been found to effectively promote the methanol homologation reaction. It appears that we have now identified the important factors leading to good A25-type additives. Our plan is to synthesize more additives that fall within this class with the goal of optimizing the desirable structural and electronic properties, and progress has been made in developing a general synthetic route to such compounds.

20165 **(DOE/PE/77049—T1) Distribution of methanol for motor vehicle use in the California South Coast Air Basin: [Final technical report].** (Energy and Environmental Analysis, Inc., Arlington, VA (USA)). Sep 1986. Contract AI01-85PE77049. 51p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006264.

This document describes a methanol distribution system (equipment, logistics, and costs) for the South Coast Air Basin (the greater Los Angeles metropolitan area) which will provide up to 250 million gallons per year of fuel methanol (an upper bound for methanol requirements in the Basin in the year 2000). Contents of this report include: (1) summary; (2) existing gasoline and diesel transport and distribution systems; (3) existing methanol transport and distribution system; (4) methanol distribution system equipment requirements; (5) distribution system expansion scenario; (6) cost of the methanol distribution system; (7) comparison of methanol and gasoline retail prices and; (8) outstanding uncertainties and concerns. 74 refs., 2 figs., 10 tabs.

20166 **(JACKFAU—86-322-8) Methanol prices during transition: [Final technical report].** (Faucett (Jack) Associates, Bethesda, MD (USA)). 12 Sep 1986. Contract AI01-85PE77049. 79p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87006265.

The information available on the worldwide capacity to produce methanol indicates a substantial excess capacity. In addition, several developing underdeveloped nations have active programs to develop new methanol capacity to utilize their available natural gas supplies. These new plants which provide local economic development can offer methanol delivered to the US at rates well below domestic production cost. The near term supply of methanol potentially available to US markets is 5 to 6 billion gallons per year of which almost 2 billion are in excess or expected 1990 world methanol demand. This capacity could be expanded rapidly to 50 to 60 billion gallons per year by utilizing all flare and reinjected gas supplies in those countries with currently active methanol production programs. Other methanol supplies could also be developed by other natural gas rich nations or from other feedstock such as coal. The highly competitive nature of this industry will keep the short-term price of this product low, at about the level of the average variable cost of the least efficient producer needed to supply a given level of methanol demand. In most scenarios under consideration methanol can be supplied to US ports at $.35 to .45 per gallon. If demand exceeds current capacity, price would approach average total cost of the least efficient producer needed to supply the market or about $.50 to .60 per gallon. These prices assume low feedstock cost for natural gas and could increase by $.10 to .20 per gallon if feedstock costs were bid up to current market prices. Future prices will be determined not only by US transportation demand for methanol, but by the level of methanol demand throughout the world.

20167 **Is there a government role in methanol market development.** Mc Nutt, B.D.; Ecklund, E.E. Warrendale, PA; Society of Auto Engineers (1986). 12p. (CONF-861041—). Society of Auto Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.

From Society of Automotive Engineers international fuels and lubricants meeting and technical display; Philadelphia, PA, USA (6 Oct 1986).

Given that a transportation fuel transition away from oil will occur, this paper explores fuel selection and government involvement. Arguments are made for choosing a petroleum replacement now, establishing methanol as the fuel of choice, planning for the transition and involving government in market readiness. Mandatory introduction of methanol compatible fuel vehicles and a national fuel distribution system, so that the marketplace can accommodate methanol when it is economicaily viable, is proposed. The cost of this approach is comparable to that of other energy activities designed to deal with transportation's oil dependence.

20168 **Distribution systems and costs for a regional fuel methanol market.** Holmes, J.G. Warrendale, PA; Society of Auto Engineers (1986). 5p. (CONF-861041—). Society of Auto Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.

From Society of Automotive Engineers international fuels and lubricants meeting and technical display; Philadelphia, PA, USA (6 Oct 1986).

This paper describes a methanol distribution system (equipment, logistics, and costs) for the California South Coast Air Basin which will provide up to 250 million gallons per year of fuel methanol for motor vehicle use. The capital cost of upgrading existing fuel distribution systems (terminals, truck fleets, and retail outlets) for methanol service are estimated at /sup 5 to /28 million depending upon the adaptability of existing gasoline systems. For these volumes of fuel methanol, distribution and retail operations are expected to add between 9 and 14 cents to the price of each gallon.

### 0903 Inorganic Hydrogen Compound Fuels

*REFER ALSO TO CITATION(S) 20162*

### 0904 Solid Waste And Wood Fuels

20169 **(EEO-ED—84-155) Waste-fired steam boiler and baling plant. Final Report.** (Department of Energy, London (UK). Energy Efficiency Office; UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; Nifes Consulting Engineers, Altringham (UK)). Jul 1986. 27p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751353.

A report is given of an Energy Demonstration Project which involved the installation of a system enabling waste material to be used as the principal source of fuel at Silentnight Holdings plc. An assessment is made of both the suitability of total waste burning to reduce/replace fuel oil consumption and the viability of baling and storing summer-produced waste for use in winter months. The report concludes that the total system achieved significant annual savings with a payback period of 4 years.

## 13 HYDRO ENERGY

### 1301 Resources And Availability

20170 (DOE/ER/60152—1-Pt.2, pp 720-728) **High elevation aquifers-potential sources of water and electrical energy.** Matthews, R.A. (Univ. of California, Davis). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The identification and development of fracture controlled high elevation aquifer systems open up a potential source of water supply, electrical power generation and reduce or eliminate water well pump costs. Geologic mapping, seismic refraction studies and photo-geologic interpretation methods were used in defining fracture lineaments. Such lineaments, expressed as surficial patterns, that are associated with climatologically controlled vegetation may be indicators of recoverable groundwater. Where such parameters are present in conjunction with specific topographic and geographic factors, significant supplies of groundwater may be developed. In some developed or developing alpine areas, adequate water sources are difficult to locate and maintain under severe climatic conditions. Under topographic and hydrogeologic conditions, near horizontal wells can be used to tap the resources. Such wells eliminate the need for pumping and can be plumbed to generate electric energy. Positive economic and environmental consideration are brought about by the elimination of fuel, pump and electrical transmission lines or fuel storage requirements.

### 1302 Site Geology And Meteorology

20171 (DOE/ER/60152—1-Pt.2, pp 650-657) **New structures in Himalayan rocks.** Chaturvaedi, A.C. (Irrigation Consultants, Lucknow, India). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Power needs of India are expected to triple from the present 36,000 MW to 108000 MW by the end of the century. A considerably large portion of those needs will be met by the power houses and storages constructed in Himalayan rocks of low permeability. Soft rocks display less elastic behavior and have low modulus of elasticity. These rocks were found to have a tendency to flow or slide as soon as the water was stored in the reservoir. The process of failure of structures was studied on models cited by computer. In many cases of practical interest, the employed methods provided the satisfactory description of the structural deformation. Special examination was made of the capacity to resist short duration motions of longer duration. The separates effects of dam water interaction and dam foundation rock interaction were investigated along with combined effects of the two sources of interaction. The harnessing of Himalayan water resources by way of constructing dams posed environmental problems which are detailed. The natural effect of these storages are studied. A number of case studies are discussed and the hydrogeological effects are monitored. 5 references.

### 1303 Plant Design And Operation

20172 **Microhydropower development in the United States: A demonstration project.** Suagee, D. (Eastern Band of Cherokee Indians, P.O. Box 455, Cherokee, NC 28719). pp 2356-2360 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

A microhydropower demonstration project has been designed and will soon be in operation on the Cherokee Indian Reservation. Like other small power producers in the U.S.A., the sponsors of this project have a right to have it interconnected with the power grid. However, this project is too small for interconnection to be cost-effective, given the costs of interconnection and the available buy-back rate. Thus the project had to be designed to use all of the power produced. The result is an integrated energy system in which microhydro will complement a passive solar retrofit that includes solar algae pond aquaculture.

### 1305 Economics And Management

*REFER ALSO TO CITATION(S) 20475*

## 14 SOLAR ENERGY

*REFER ALSO TO CITATION(S) 20479*

### 1401 Resources And Availability

20173 (UK-ISES—C40, pp 65-68) **Estimation of diffuse radiation from meteorological data.** Al-Ayfari, H.H. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

The results of research in the Solar Energy Laboratory of the University of Birmingham are reported. A model which predicts the diffuse component of solar radiation from weather data is presented. The results of these predictions are statistically analysed and it is found that they compare favourably with previous models.

20174 (UK-ISES—C40, pp 74-79) **Basic weather model for energy analyses.** Paassen, A.H.C. van; Liem, S.H. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

A statistical model of the outdoor climate has been derived. It can generate a new set of hourly weather data of any length. A basic version, which applies to a large area can be defined. Local differences are implemented by changing some parameters, such as mean values of the weather variables. With this model, reference years (even for locations with incomplete data) can now be generated.

20175 (UK-ISES—C40, pp 80-84) **Solar and building analysis energy on microcomputers: Monthly average methods.** Mitchell, J.W. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

The analysis of solar and building energy systems is often done using simulation techniques. Simulations require detailed weather records for the time period in question, which is often a year. The performance of the system is then determined on an instantaneous basis, often using hourly timesteps. Monthly values of performance are obtained by integrating the instantaneous values. While this approach accurately accounts for the transient response of the various pieces of equipment and weather fluctuations, the calculations for a complex system are time consuming. There is a need for simplified techniques which produce monthly values of energy consumption and delivery and which capture the effects of weather fluctuations and system dynamics. Methods which allow the monthly average characterization of weather are discussed.

20176 **Solar radiation modeling using satellite data.** Riordan, C. (Solar Energy Research Institute, 1617 Cole Boulevard, Golden, CO 80401). pp 2543-2547 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper briefly reviews the technical and practical aspects of models that predict solar energy resources at the earth's surface using satellite data. Conclusions are that these satellite methods are technically feasible, but detailed information on cost and accuracy is needed to perform cost/benefit analyses. Future research should focus on areas of greatest potential improvement to the cost/benefit ratio.

### 1403 Economics

*REFER ALSO TO CITATION(S) 20244*

### 1404 Environmental, Legal, And Institutional Aspects

*REFER ALSO TO CITATION(S) 20239*

### 1405 Solar Energy Conversion

*REFER ALSO TO CITATION(S) 20160, 20675, 20769, 21116, 21144, 21145, 21153, 21188*

20177 (AD-A—175306/0/XAB) **Autonomous circuit for the measurement of photovoltaic-device parameters. Master's thesis.** Callaway, R.K. (Naval Postgraduate School, Monterey, CA (USA)). Sep 1986. 86p. NTIS, PC A05/MF A01.

In this research a novel autonomous test system is presented. The system is a self-contained microprocessor-based experiment, which was developed to compare and test different state-of-the-art gallium arsenide and silicon solar cells. The results will help evaluate radiation-hardness properties of both types of solar cells. The

system can also be used to study the annealing process as well as shadowing effects in space-array systems. Stringent requirements were considered in designing the system for durable operation in a space environment.

20178 (CEA-CONF—8680) **Exafs study of c-Si, a-Si and a-Si:H.** Menelle, A.; Bellissent, R.; Flank, A.M.; Lagarde, P. (Laboratoire Leon Brillouin, Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). 1986. 5p. (CONF-860753—8). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751682.

From International conference on EXAFS and near edge structure; Saumur, France (7 Jul 1986).

In order to determine the role played by the hydrogen atoms in a-Si:H, short range order has been investigated using Exafs at the silicon K-edge. Emphasis has been put on topological disorder; low temperature measurements allowed us to look at its variations. Concerning hydrogen, a non homogeneous distribution has been deduced and a 2-d or l-d repartition consistent with both theoretical prediction and small angle neutron scattering data is proposed.

20179 (DOE/CH/10093—H2) **Photovoltaic energy systems: Program summary, Fiscal year 1986.** (Solar Energy Research Inst., Golden, CO (USA)). Dec 1986. Contract AC02-83CH10093. 302p. NTIS, PC A14/MF A01; 1; GPO Dep. File Number DE87006582.

An overview is provided of the government funded activities within the National Photovoltaics Program. Tasks conducted in-house by the participating national laboratories or under contract by industrial, academic and other research institutions are highlighted. Activities initiated, renewed, or completed during Fiscal Year 1986 are covered. The listing for each activity provides the task title, objectives, approach, status and accomplishments, milestones, major project reports, the name of the contractor and principal investigator, the directing organization, and the contract funding information. Publications for FY85 and FY86 are also listed. (LEW)

20180 (DOE/ER/13187—3) **Particulate models of photosynthesis: Final report for the period April 8, 1980-September 7, 1986.** Seely, G.R. (Battelle-Charles F. Kettering Research Lab., Yellow Springs, OH (USA)). Nov 1986. Contract FG02-84ER13187. 25p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006267.

A new model system for investigation of chlorophyll-sensitized photochemical energy-conversion reactions has been developed. The system consists of chlorophyll adsorbed with other amphiphilic materials to viscous, swollen polyethylene particles, suspended in an aqueous medium also rendered viscous with high polymers. The high viscosity of the particles prevents bimolecular quenching reactions that would otherwise limit chlorophyll singlet state photochemistry. Chlorophyll is maintained in states of low aggregation by amphiphiles that coordinate with the Mg. Such preparations are characterized by complex absorption spectra and strong fluorescence from chlorophyll aggregates as well as monomer, which depend on the structure of the bound amphiphile. A large number of photochemical reactions of chlorophyll and pheophytin have been observed with this system, including several without known analogs in homogeneous and other heterogeneous systems. A novel feature of this system is the incorporation of oxidizing amphiphiles, molecules that simultaneously adsorb to the particles, ligate the Mg of chlorophyll, and accept an electron from its excited state. The Report summarizes published and otherwise unpublished work on these and other aspects of the model system. 19 refs., 5 figs.

20181 (DOE/JPL—1012-122, pp 3-12) **Silicon Material Task of the DOE/FSA Project.** Lutwack, R. Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

The Silicon Material Task of the FSA Project has been described through the reports of the contractors, through JPL reports, and through presentations by JPL and the contractors at various meetings. In fact, eight papers presented at this Workshop deal with investigations carried out entirely or in part under the Task. An insight into the Task program from its inception in 1974 is presented.

20182 (DOE/JPL—1012-122, pp 15-36) **Effects of impurities on silicon solar-cell performance.** Hopkins, R.H. (Westinghouse R & D Center, Pittsburgh, PA). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

Model analyses indicate that sophisticated solar cell designs including, e.g., back surface fields, optical reflectors, surface passivation, and double layer antireflective coatings can produce devices with conversion efficiencies above 20% (AM1). To realize this potential, the quality of the silicon from which the cells are made must be improved; and these excellent electrical properties must be maintained during device processing. As the cell efficiency rises, the sensitivity to trace contaminants also increases. For example, the threshold Ti impurity concentration at which cell performance degrades is more than an order of magnitude lower for an 18% cell than for a 16% cell. Similar behavior occurs for numerous other metal species which introduce deep level traps that stimulate the recombination of photogenerated carriers in silicon. Purification via crystal growth in conjunction with gettering steps to preserve the large diffusion length of the as-grown material can lead to the production of devices with efficiencies above 18%, as the authors have verified experimentally.

20183 (DOE/JPL—1012-122, pp 37-53) **Requirements for high-efficiency solar cells.** Sah, C.T. (Univ. of Illinois, Urbana). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

Minimum recombination and low injection level are essential for high efficiency. Twenty percent AM1 efficiency requires a dark recombination current density of $2 \times 10^{-13}$ A/cm$_3$ and a recombination center density of less than about $10^{10}$ cm$^{-3}$. Recombination mechanisms at thirteen locations in a conventional single-crystalline silicon cell design are reviewed. Three additional recombination locations are described at grain boundaries in polycrystalline cells. Material perfection and fabrication process optimization requirements for high efficiency are outlined. Innovative device designs to reduce recombination in the bulk and interfaces of single-crystalline cells and in the grain boundary of poly-crystalline cells are reviewed.

20184 (DOE/JPL—1012-122, pp 57-77) **Economics of polysilicon process-A view from Japan.** Shimizu, Y. (Osaka Titanium Co., Ltd., Hyogo, Japan). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

The production process of solar-grade silicon (SOG-Si) through trichlorosilane (TCS) in a program sponsored by New Energy Development Organization (NEDO) is discussed. The NEDO process consists of the following two steps: (1) TCS production from by-product silicon tetrachloride (STC), and (2) SOG-Si formation from TCS using a fluidized-bed reactor (FBR). Based on the data obtained during the research program, the manufacturing cost of the NEDO process and other polysilicon manufacturing processes were compared. The manufacturing cost was calculated on the basis of 1000 tons/year production. Actual manufacturing costs are difficult to compare because of differences in local conditions, production scale, contents of direct and indirect costs and reliability of published data. To reduce these differences, the published data were modified according to a certain method prior to manufacturing cost calculation. The cost estimate showed that the cost of producing silicon by all of the new processes is less than the cost by the conventional Siemens process. The SOG-Si manufacturing processes using FBR, (the NEDO and UCC-JPL FBR process-

es,) which need further development for practical application, have a greater probability of cost reduction than the filament processes.

20185 (DOE/JPL—1012-122, pp 79-122) **Economics of polysilicon processes.** Yaws, C.L.; Li, K.Y.; Chou, S.M. (Lamar Univ., Beaumont, TX). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

New technologies are being developed to provide lower cost polysilicon material for solar cells. Existing technology which normally provides semiconductor industry polysilicon material is undergoing changes and also being used to provide polysilicon material for solar cells. Economics of new and existing technologies are presented for producing polysilicon. The economics are primarily based on the preliminary process design of a plant to produce 1000 metric tons/year of silicon. The polysilicon processes include: Siemens process (hydrogen reduction of trichlorosilane); Union Carbide process (silane decomposition) and Hemlock Semiconductor process (hydrogen reduction of dichlorosilane). The economics include cost estimates of capital investment and product cost to produce the polysilicon via the technology. Sensitivity analysis results are also presented to disclose the effect of major parameters such as utilities, labor, raw materials and capital investment.

20186 (DOE/JPL—1012-122, pp 123-132) **Sensitivity analysis for solar panels.** Aster, R.W. Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

The Project Analysis and Integration (PA & I) task of the Flat-Plate Solar Array (FSA) project has prepared economic evaluation methods and analyses of emerging photovoltaic (PV) technology since 1976. This type of analysis was applied to the silicon research portion of the PV program in order to determine the importance of this research effort in relationship to the successful development of commercial PV systems. This analysis addresses all four of the generic types of PV that use silicon. The first generic type of PV is the one that uses the most silicon, where crystalline silicon ingots are grown either by the Czochralski method or by some sort of ingot casting method. The second type of PV uses ribbons that are pulled directly from molten silicon, thus avoiding material losses associated with sawing wafers from an ingot. The third type of PV device is an amorphous silicon thin film, which attempts to achieve low cost by minimizing silicon material utilization. A fourth type of PV device is the concentrator system, which can use high concentration lenses (500x to 1000x) to minimize silicon material utilization. This last type of PV technology can be analyzed very simply because the amount of silicon used will be roughly 500 to 1000 times less per unit of PV energy produced than would be the case with the first generic type of PV.

20187 (DOE/JPL—1012-122, pp 135-145) **Development of the silane process for the production of low-cost polysilicon.** Iya, S.K. (Union Carbide Corp., Washougal, WA). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

The technology for producing low-cost polysilicon for terrestrial photovoltaic solar cell applications is discussed. A licensing agreement was arranged with Komatsu Electronic Metals of Japan to obtain commercially proven technology for decomposing silane to produce polycrystalline silicon. Construction of the silane-to-silicon development units was completed in 1982, and it was operated successfully to produce silane and polysilicon of exceptionally high purity for the electronics industry. Based on the original design data base developed under the JPL/DOE program, UCC constructed a 1200 metric tons per year capacity commercial plant in Moses Lake, Washington. This plant was brought on stream in early 1985, and is currently supplying high purity polysilicon to the industry. The UCC silane process and the research and development (R & D) work on fluidized bed silane decomposition conducted under JPL/DOE sponsorship are discussed.

20188 (DOE/JPL—1012-122, pp 147-166) **Fluidized-bed development at JPL.** Hsu, G. Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

Silicon deposition on silicon seed particles by silane pyrolysis in a fluidized bed reactor (FBR) has been under investigation as a low-cost, high throughput method to produce high purity polysilicon for solar cell applications. The emphasis of the research at JPL is fundamental understanding of fluidized bed silicon deposition. The mechanisms involved were modeled as a six-path process: (1) heterogeneous deposition; (2) homogeneous decomposition; (3) coalescence; (4) coagulation; (5) scavenging; and (6) chemical vapor deposition growth on fines.

20189 (DOE/JPL—1012-122, pp 167-185) **Fluidized-bed reactor modeling for production of silicon by silane pyrolysis.** Dudukovic, M.P.; Ramachandran, P.A.; Lai, S. (Washington Univ., St. Louis, MO). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

Traditionally high purity silicon for solar and electronic applications has been produced in Siemens decomposers by hydrogen reduction of chlorosilanes. The yield in the Siemens process is poor. The new cheap routes to silane offer an attractive alternative for silicon production via silane pyrolysis. Fluidized beds offer an attractive possibility, an extensive experimental studies have been conducted. Modeling efforts have lagged far behind the experimental activities. The objective of this study was to develop a mathematical model for fluidized bed pyrolysis of silane that related production rate and product silicon properties (such as size, size distribution, presence and absence of fines) with fluidized-bed size and operating parameters (such as wall temperature, feed concentration, gas flow rate, seed size, etc.) and with bed grid design. Upon model verification it is desired to expand the model to account for product morphology, i.e., porous versus nonporous particles, etc. While fluidized-bed models for catalytic processes are abundant and models for gas-solid reactions with changing solids have been well established by Kunii and Levenspiel, a comprehensive model needed for simultaneous chemical vapor deposition and nucleation reactions has not been reported.

20190 (DOE/JPL—1012-122, pp 187-209) **Silicon production in an aerosol reactor.** Wu, J.J.; Flagan, R.C. (California Institute of Technology, Pasadena, CA). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

The production of bulk solar-grade silicon by homogeneous gas-phase pyrolysis of silane has been the subject of a number of investigations. While very high efficiencies of conversion of silane to silicon were achieved in those early studies, the silicon powder generated consisted of low density agglomerates of submicron particles. This powder was difficult to collect and melt. Moreover, the product purity was inadequate for the intended use. In 1980, a study of the factors limiting particle growth in the so-called free space reactor was undertaken. This work has led to an improved understanding of the fundamental processes involved in the formation of low vapor pressure particles by gas phase chemical reactions, and, as a result of this understanding, to the development of a new type of aerosol reactor for the processing of high purity materials. The focus of recent work under this program has been on elucidating the operating regimes in which particles can be grown to large enough size to facilitate separation of the product from the gas. The major developments of this program are summarized.

20191 (DOE/JPL—1012-122, pp 213-231) **Processes and process developments in Japan.** Noda, T. (Osaka Titanium Co., Ltd., Hyogo, Japan). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

The commercialization of solar power generation necessitates the development of a new, low-cost manufacturing method of silicon suitable for solar cells. To this end, a special work group was formed in the Japan Electrical Manufacturers Association in 1978, and it inaugurated a variety of research programs. The Group investigated the manufacturing methods of semiconductor grade silicon (SEG-Si) and the development of solar grade silicon (SOG-Si) in foreign countries. The authors concluded that the most efficient method of developing such materials was the hydrogen reduction process of trichlorosilane (TCS), using a fluidized-bed reactor (FBR). The reasons were: TCS had been proved in a number of studies to be an appropriate material for this purpose; the budget was insufficient to test several processes simultaneously; and the hydrogen reduction process seemed to have high feasibility for practical application as revealed by studies conducted thus far. This process was viewed as meeting the following conditions: (1) the process is suited to mass production, an essential point for future development; and (2) the process reduces manufacturing costs to a greater extent than conventional SEG-Si manufacturing processes. The low-cost manufacture of polysilicon requires cost reductions of raw materials, energy, labor, and capital. This process is described.

20192 (DOE/JPL—1012-122, pp 233-249) **Processes and process development in Taiwan.** Hwang, H.L. (National Tsing Hua Univ., Hsin-chu, Taiwan). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

Silicon material research in ROC parallels its development in electronic industry. A brief outline of the historical development in ROC silicon material research is presented. Emphasis is placed on the recent Silane Project managed by the National Science Council, ROC, including project objectives, task forces and recent accomplishments. An introduction is also given to industrialization of the key technologies developed in this project.

20193 (DOE/JPL—1012-122, pp 251-266) **Refining of metallurgical-grade silicon.** Dietl, J. (Heliotronic GmbH, Burghausen, West Germany). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

A basic requirement of large-scale solar cell fabrication is to provide low-cost base material. Unconventional refining of metallurgical-grade silicon represents one of the most promising ways of silicon meltstock processing. The refining concept is based on an optimized combination of metallurgical treatments. Commercially available crude silicon, in this sequence, requires a first pyrometallurgical step by slagging, or, alternatively, solvent extraction by aluminum. After grinding and leaching, high purity quality is gained as an advanced stage of refinement. To reach solar-grade quality a final pyrometallurgical step is needed: liquid-gas extraction.

20194 (DOE/JPL—1012-122, pp 267-278) **Solar-grade silicon prepared by carbothermic reduction of silica.** Aulich, H.A.; Schulze, F.W.; Urbach, H.P.; Lerchenberger, A. (Siemens Research Labs., Muenchen, West Germany). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

An advanced carbothermic reduction (ACR) process was developed to produce solar-grade (SG) silicon from high-purity silica and carbon. Preparation of starting materials and operation of the arc-furnace to produce high-purity silicon is described. Solar cells prepared from single crystal SG-Si had efficiencies of up to 12.3%, practically identical to cells made from electronic-grade (EG) silicon. The ACR process is now in the pilot stage for further evaluation.

20195 (DOE/JPL—1012-122, pp 279-295) **Metallurgical route to solar-grade silicon.** Schei, A. (Elkem a/s, R & D Center, Kristiansand S, Norway). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

The aim of the process is to produce a silicon for crystallization into ingots that can be sliced to wafers for processing into photovoltaic cells. The specifications of the product are given. If the potential purity can be realized, the silicon will also be applicable for ribbon pulling techniques where the purification during crystallization is negligible. The process consists of several steps: Selection and purification of raw materials, carbothermic reduction of silica, ladle treatment, casting, crushing, leaching and remelting. The leaching step is crucial for high purity, and the obtainable purity is determined by the solidification before leaching. The most difficult specifications to fulfill are the low contents of boron, phosphorus and carbon. Boron and phosphorus can be excluded from the raw materials, but the carbothermic reduction will unavoidably saturate the silicon with carbon at high temperature. During cooling carbon will precipitate as silicon carbide crystals, which will be very harmful in solar cells. The cost of this solar silicon will depend strongly on the scale of production. It is as yet premature to give exact figures, but with a scale of some thousand tons per year, the cost will be only a few times the cost of ordinary metallurgical silicon.

20196 (DOE/JPL—1012-122, pp 297-321) **Solar silicon from directional solidification of MG silicon produced via the silicon carbide route.** Rustioni, M.; Margadonna, D.; Pirazzi, R.; Pizzini, S. (Univ. of Milano, Italy). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

A novel process for the production of MG silicon is presented which appears particularly suitable for PV applications. The MG silicon is prepared in a 240 KVA, three electrode, submerged arc furnace, starting from high grade quartz and high-purity silicon carbide. This silicon carbide was obtained by reacting in a Acheson type of furnace, high grade sand and carbon black. The silicon smelted from the arc furnace under very smooth furnace operation has been shown to be sufficiently pure to be directionally solidified to 10-15 Kg, 23cm x 23cm$^2$ bricks, after grinding to less than 5 mm grain size and acid leaching, with a material yield larger than 90%. With a MG silicon feedstock containing about 3 ppmw B, 490 ppmw Fe, 190 ppmw Ti and 170 ppmw Al, blended with 50% of off grade EG silicon to increase the boron content to a concentration acceptable for solar cell fabrication, the 99% of deep level impurities concentrated in the last 5% of the ingot, which appears structurally perfect in the rest, after the first crystallization, while deep level impurities are close to the detection limits by the ICP-ES technique after a second crystallization.

20197 (DOE/JPL—1012-122, pp 325-345) **Characterization of solar-grade silicon produced by the $SiF_4$-Na process.** Sanjurjo, A.; Sancier, K.M.; Emerson, R.M.; Leach, S.C.; Minahan, J. (SRI International, Menlo Park, CA). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

A process for producing low-cost solar grade silicon by the reaction between $SiF_4$ gas and sodium metal is discussed. Results of the characterization of the silicon are presented. These results include (a) impurity levels, (b) electronic properties of the silicon

after crystal growth, and (c) the performance of solar photovoltaic cells fabricated from wafers of the single crystals. The efficiency of the solar cells fabricated from semiconductor silicon and $SiF_4$-Na silicon was the same.

20198 (DOE/JPL—1012-122, pp 347-366) **Silane-based polysilicon process.** Grayson, P.E.; Jaffe, J. (Eagle-Picher Industries, Inc., Miami, OK). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

A joint development program to pilot demonstrate a silane based polysilicon process was constructed. The process as piloted included the synthesis of crude silane gas, ultrapurification of the gas, and then direct pyrolysis to product silicon. Features of the process provided for direct continuous operation from process feed to final product, without the requirement to store intermediates or to convert the silane to a liquid phase. Semiconductor quality product as analyzed internally, and confirmed by independent laboratories, was demonstrated by the first integrated operation of the plant. The project organizational responsibilities are shown. The pilot plant was constructed by the engineering and technical staff of the participating companies in residence at the miami, Oklahoma site. The results of the first integrated operation of the plant. The process development, although considered by all participants to be technically and financially very successful was abandoned in late 1982 for business reasons unrelated to this project.

20199 (DOE/JPL—1012-122, pp 367-377) **Silicon purification using a Cu-Si alloy source.** Powell, R.C.; Tejedor, P.; Olson, J.M. (Solar Energy Research Institute, Golden, CO). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

Production of 99.9999% pure silicon from 98% pure metallurgical-grade silicon by a vapor-transport filtration process (VTF) is described. The VTF process is a cold-wall version of an HCl chemical vapor transport technique using a $Si:Cu_3Si$ alloy as the silicon source. The concentration, origin, and behavior of the various impurities involved in the process were determined by chemically analyzing alloys of different purity, the slag formed during the alloying process, and the purified silicon. Atomic absorption, emission spectrometry, inductively coupled plasma, spark source mass spectrometry, and secondary ion mass spectrometry were used for these analyses. The influence of the Cl/H ratio and the deposition temperature on the transport rate was also investigated.

20200 (DOE/JPL—1012-122, pp 397-416) **Semiconductor market.** Pellin, R. Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

Electronic grade polycrystalline silicon is the basic raw material of the electronic industry and will remain the most important semiconductor material for the rest of this century. The technology of manufacture of silicon devices has advanced rapidly and the physics of the material, silicon, will allow this technology to continue to improve rapidly. Since 1975, the computational power of silicon devices has increased by a factor of a thousand for a price increase of only a factor of six. During the next ten years a similar 1000 fold increase in the computational power of silicon devices for a price increase of only a factor of six will again take place. Other materials will be used in the manufacture of electronic devices but such devices will only be supplementary to the silicon electronics that exists today. Forecasting the amount of polycrystalline silicon that will be used in future years is not a simple task. Obviously the amount of polycrystalline silicon used will correlate with the number of silicon devices manufactured and the number of silicon devices manufactured will correlate with the value of electronic equipment produced. A forecast of polycrystalline silicon usage is presented based on forecasts of the production of electronic equipment and silicon electronic devices.

20201 (DOE/JPL—1012-122, pp 417-425) **Silicon requirements of the photovoltaic solar cell market.** Maycock, P.D. (PV Energy Systems, Inc., Casanova, VA). Feb 1986. NTIS, PC A18/MF A01. File Number DE87005426. (JPL-PUB—86-11; CONF-8510405—).

From Flat-Plate Solar Array Project workshop on low-cost polysilicon for terrestrial photovoltaic solar-cell applications; Las Vegas, NV, USA (28 Oct 1985).

The terrestrial photovoltaic module market is summarized for 1983 through 1985 and a module shipment forecast developed for 1990 and 1995. The PV module shipments for each major cell material option: single crystal silicon, polycrystal cast silicon, silicon sheet, silicon concentrator cells, amorphous silicon and other materials, is forecast. A silicon consumption factor (kilograms used per kilowatt) for the present product and for each cell option is shown. The reduction in silicon usage as processes are improved, and efficiencies are forecast to 1995 for each option. Given the market, the technology mix, and the silicon usage forecast, an aggregate silicon consumption estimate will be made for a high case (U.S. tax credits extended), and a low case (U.S. tax credits terminate).

20202 (N—87-13704, pp vp) **Low-background InSb array development.** Thom, R.D.; Yang, B.T. Feb 1986. NTIS, PC A15/MF A01. (NASA-TM—88213; A—86123; NAS—1.15:88213; CONF-8508227—).

From 2. infrared detector technology workshop; Moffett Field, CA, USA (13 Aug 1985).

Photovoltaic indium antimonide (PV InSb) detector technology has matured over the past several years to enable a wide variety of applications to use this high-performance detector material to advantage. The operating conditions for most of the applications to date for back-side illuminated PV InSb arrays have encompassed focal plane temperatures ranging from 40 to approximately 95 K, with the majority in the narrower range between 60 and 80 K. Background flux conditions have ranged from 10 to the 10th power ph/sq cm/sec to 10 to the 16th power ph/sq cm/sec, most typically between 10 to the 12th power and 10 to the 14th power ph/sq cm/sec. Appropriately, the array parameters were optimized for maximum performance over these temperature and background ranges. The key parameters which were peaked in this process were the resistance-area product of the detectors and their quantum efficiency. The Space Infrared Telescope Facility (SIRTF) Infrared Array Camera requirements, however, present very low temperature and background operating conditions, plus the need for very high signal to noise ratios. Preliminary analysis indicates that back-side illuminated PV InSb arrays can be optimized for operation under these conditions, and some performance projections will be presented.

20203 (SAND—86-7038) **Evaluation of a heliostat tracker for linear Fresnel lens photovoltaic concentrators.** (Entech, Inc., Dallas-Fort Worth Airport, TX (USA); Sandia National Labs., Albuquerque, NM (USA)). Dec 1986. Contract AC04-76DP00789. 30p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006331.

This report presents the results of an evaluation of a heliostat tracking structure used as a two-axis tracking platform for ENTECH's linear focus Fresnel lens photovoltaic collectors. The study included the installation and operation of a heliostat tracker populated with 30 modules (1 operational and 29 non-operational) on a 32-ft x 32-ft platform. Details of the array installation, collector mounting, and array tracking accuracy are provided. Test results demonstrate that the heliostat tracker meets the performance requirements imposed by the collector. The evaluation includes a comparison of the heliostat tracker approach with the current tracker approach (a roll/tilt array). Results of the comparison do not identify a clearly superior option.

20204 (SAND—86-7048) **Computer modeling of high intensity solar cells.** Gray, J.L.; Lundstrom, M.S.; Schwartz, R.J. (Purdue Univ., Lafayette, IN (USA). School of Electrical Engineering; Sandia National Labs., Albuquerque, NM (USA)). Jan 1987. Contract AC04-76DP00789. 112p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87005970.

The purpose of this program is to provide general analytic support to Sandia National Laboratories' effort to develop high efficiency, high concentration solar cells. This report covers work performed between November 5, 1984, and December 31, 1985, and includes reprints of three papers presented at the 18th IEEE Photovoltaic Specialists' Conference. In the first paper, the factors that presently prevent achieving the predicted theoretical efficiencies (in excess of 30% at concentration) are examined. It is demonstrated, by two-dimensional computer simulations, that these efficiencies might be obtained by improved light trapping techniques and by fabrication of low resistance heteroface contacts. The second paper examines the Rose-Weaver lifetime and surface recombination velocity measurement technique. It is shown that the very small uncertainties in the measured quantities lead to large uncertainties in the computed lifetime and surface recombination velocity. This leads to radically different interpretations of how the recombination is distributed throughout the device, and therefore limits the usefulness of the measurement technique. Design options and constraints of GaAs concentrator cells are examined in the third paper. The effectiveness of various design options is assessed. It is shown that although such design options are of little use in increasing the efficiency of heteroface cells, they can improve the efficiency of shallow junction cells so that it is comparable to that of heteroface cells, In addition, documentation describing the use of both the one- and two-dimensional silicon codes, SCAP1D and SCAP2D, as well as the one-dimensional AlGaAs solar cell simulation code is included.

20205 (SERI/CP—211-3086, pp 1-9) **Glow-discharge, film growth and characteristics.** Gallagher, A. (National Bureau of Standards, Boulder, CO). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

The structure of glow-discharge a-Si:H films generally make a progression from microcrystalline to low-defect amorphous to high-defect amorphous as the discharge gas changes from H-rich to H-poor, and as discharge power is increased. The author describes a model for the discharge gas and surface processes that lead to film growth, and for the causes of the film quality changes.

20206 (SERI/CP—211-3086, pp 13-19) **Characterization of light-induced effects in amorphous silicon alloy materials.** Collis, W.J.; Iyer, S.; Shah, A. (North Carolina A & T State Univ., Greensboro). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

The objective of this research effort is the development of a measurement system and techniques for characterizing the light induced changes which are observed to occur in intrinsic hydrogenated amorphous Si (a-Si:H) and related alloy materials (the Staebler-Wronski effect). This system is used to study the dark and photoconductivity changes as a function of wavelength, light exposure intensity, and annealing temperature in a variety of amorphous samples obtained from various sources. It is recognized that, while the objective is to compare the behaviors of samples prepared under differing conditions, such a comparison is complicated by the nature of the deposition processes, the thickness of the amorphous films, intentional or unintentional impurities, and the type of substrate material. 3 references, 4 figures.

20207 (SERI/CP—211-3086, pp 23-32) **Electrochemical photocapacitance spectroscopy of amorphous silicon alloy materials.** Haak, R. (Rockwell International Science Center, Thousand Oaks, CA). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

The objective of this program has been to develop the technique of electrochemical photocapacitance spectroscopy (EPS) as an analytical tool to map the intrabandgap energy level distributions of hydrogenated amorphous silicon (a-Si:H). Such states play a key role in determining the electronic properties of the i-layer in p-i-n a-Si:H devices. Experimental details and results of the EPS research program are given.

20208 (SERI/CP—211-3086, pp 35-44) **Numerical solutions, physical interpretations, and analytical models for amorphous silicon P/I/N solar cells.** Misiakos, K.; Lindholm, F.A. (Univ. of Florida, Gainesville). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

Analytical and equivalent-circuit models for a-Si:H p/i/n solar cells are presented. These models are derived from the physical interpretation of contact-to-contact computer solutions of the Poisson and the electron and hole continuity and current equations.

20209 (SERI/CP—211-3086, pp 47-56) **Laser in situ diagnostics and process modeling of glow discharge amorphous silicon deposition.** Shing, Y.H.; Perry, J.W.; Hsu, G.; Hermann, A. (Jet Propulsion Lab., Pasadena, CA). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

In situ process diagnostics using coherent anti-Stokes Raman spectroscopy (CARS) have been performed under state-of-the-art a-Si:H film deposition conditions in a reactor designed for a-Si:H solar cell fabrications. Intrinsic a-Si:H films with a light-to-dark conductivity ratio of $6.5 \times 10^5$ (100 mW/cm², AM1 illumination) were deposited by RF glow discharge of pure silane with flow rate of 40 sccm and RF power density of 22 mW/cm². The silane plasma of these device-quality a-Si:H depositions was analyzed by CARS using a crossed-beam configuration consisting of two pump laser beams of 532 nm and a fine-tuned dye laser beam in the range of 573-607 nm. The CARS signal of $SiH_4$ shows that the $SiH_4$ depletion ratio in low power RF glow discharge is linearly dependent on the power density. Transient phenomena in the depletion and the recovery of silane have been observed by measuring CARS of $SiH_4$ during ON-OFF glow discharge transitions. There exists a long time constant in both the depletion and the recovery rate which may involve the growing film surface. The significance of relating the surface reactions in a-Si:H growing process with the slow kinetics of $SiH_4$ evolution is being investigated further. A simplified model calculation for the a-Si:H deposition process has been performed. Initial good agreement between the calculated and the measured deposition rates has been obtained. 8 references, 9 figures, 1 table.

20210 (SERI/CP—211-3086, pp 69-73) **Recent status of photovoltaic materials & their prospects in China.** Jinglun, Z.; Qun, W.; Dechuan, X. (State Science and Technology Commission, China). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

Photovoltaic research in the People's Republic of China is briefly discussed. The present status of the research is given, along with plans for the development of a-Si materials and solar cells in China.

20211 (SERI/CP—211-3086, pp 79-88) **Photo-chemical vapor deposition of hydrogenated amorphous silicon photovoltaic devices.** Rocheleau, R.E.; Hegedus, S.S.; Baron, B.N. (Univ. of Delaware, Newark). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

A relatively new technique for depositing amorphous silicon (a-Si:H) is photo-CVD which utilizes ultraviolet light to initiate the gas phase decomposition of silane or disilane. The radiation may be absorbed directly by the reactant gases or by a sensitizer such as Hg. The highest efficiency photo-CVD cells reported to date (11.2%) were deposited using Hg sensitized silane for the i-layers. The object of the work presented was to optimize Hg sensitized

deposition of intrinsic amorphous silicon and to produce a 9% efficient all photo-CVD p-i-n device. The highest efficiency to date is 9.3% with voc=.85V; Jsc=15.5 mA/cm; and FF=61.6% at 87.5 mW/cm². Reactor analysis is being used along with materials and device characterization to quantitatively evaluate the photo-CVD process.

20212 (SERI/CP—211-3086, pp 95-106) **Studies of chemical vapor deposition of amorphous silicon and transparent electrodes for solar cells.** Gordon, R.G.; McCurdy, R.J.; Proscia, J. (Harvard Univ., Cambridge, MA). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

Brief descriptions of several research projects concerning solar cells are presented. Included are CVD of hydrogenated amorphous silicon; CVD of rough fluorinated tin oxide transparent electrodes; CVD of hydrogenated amorphous silicon; properties of tin oxide films as a function of thickness; and results of solar cells grown on rough tin oxide.

20213 (SERI/CP—211-3086, pp 111-134) **Amorphous Si-Ge alloys made from ($SiH_4$ + $GeH_4$) and ($SiF_4$ + $GeF_4$ + $H_2$): a comparison.** Mackenzie, K.D.; Paul, W. (Harvard Univ., Cambridge, MA). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

It is generally accepted that a-Si/sub 1-x/Ge/sub x/, with $x \approx 0.5$, possesses an optical gap suitably smaller than that of a-Si:H for several applications. It is usually found, however, that this material, no matter how it is prepared, has photoelectronic properties inferior to those of a-Si:H. The report presented reviews evidence and experiments that suggest that the cause of the deterioration in the properties may lie partly in a band structure with a higher gap density of states, and partly in a looser, more defected microstructure on a scale of 100 angstroms.

20214 (SERI/CP—211-3086, pp 137-146) **Effects of band bending on the electrical and photo-electronic properties of a-Si:H and a-Ge:H thin films in surface cell structures.** Parsons, G.N.; Kusano, C.; Lucovsky, G. (North Carolina State Univ., Raleigh). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

The authors have studied the optical, electrical and photoelectronic properties of a-Si:H and a-Ge:H thin films in surface cell structures and have concluded that upward band bending (i.e., depletion regions) at surfaces exposed to dry nitrogen and at a-Si:H and a-Ge:H/silica glass interfaces makes many of these properties appear to be thickness dependent. They show that the alloy films are homogeneous with respect to hydrogen incorporation, etc., and that any thickness dependence of dark and photocurrents can be accounted for quantitatively in terms of a model that includes an electronic inhomogeneity, in the sense of depletion regions at both thin film surfaces. 19 references, 8 figures.

20215 (SERI/CP—211-3086, pp 149-158) **Influence of microstructure on the photoconductivity of glow discharge deposited amorphous SiC:H and amorphous SiGe:H alloys.** Mahan, A.H.; Raboisson, P.; Menna, P.; Tsu, R. (Solar Energy Research Institute, Golden, CO). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

The authors introduce a parameter obtained from infrared measurements as a means of quantifying the amount of amorphous silicon microstructure and its degree of passivation by hydrogen. Using this parameter, the photoconductivities of amorphous silicon (a-Si:H), amorphous silicon carbon (a-SiC:H), and amorphous silicon germanium (a-SiGe:H) fall on the same curve. They discuss the relevance of these results as regards to material quality.

20216 (SERI/CP—211-3086, pp 161-171) **Single and multi-junction A-Si alloy solar cells.** Bragagnolo, J.A.; Greenwald, A.; Leonard, M.; Mastrovito, A.; Littlefield, P.; Dalal, V.L. (Spire Corp., Bedford, MA). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

The authors discuss the design and characteristics of a-Si:H, a-(Si,Ge):H and tandem cells fabricated in a multi-sensor, radio frequency triode plasma deposition system. Optimization of a-Si:H and $SnO_2$:F deposition and of the device photon economy has led to the achievement of a-Si:H cells of over 10% efficiency. Further optimization of a 1.4 eV bandgap a-(Si,Ge):H alloy could lead to tandem cells with efficiencies in excess of 11%. 9 references, 7 figures, 3 tables.

20217 (SERI/CP—211-3086, pp 175-184) **Amorphous silicon PV R & D activities in Europe.** Palz, W.; Van Overstraeten, R.; Willeke, G. (CEC, Brussels, Belgium). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

The amorphous silicon thin film technology can be considered a promising candidate for future low cost alternative energy conversion. On the fundamental and applied side, European institutions and in particular the Commission of the European Communities have made significant contributions. This paper gives an outline of present a-Si photovoltaic R & D activities coordinated by the Commission. Additional information on the major European national programs is also given. 2 references, 1 table.

20218 (SERI/CP—211-3086, pp 189-197) **Investigation of light-induced defect creation in a-Si:H using junction capacitance methods.** Cohen, J.D.; Mahavadi, K.K.; Zellama, K. (Univ. of Oregon, Eugene). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

From junction capacitance measurements they have determined the density, energy distribution, and electronic occupation of light-induced metastable defects near midgap for a set of nearly intrinsic hydrogenated amorphous silicon samples with well characterized impurity levels. In particular, they have inferred the changes in both neutral and negative dangling bonds for a series of isochronal anneals between the light soaked state and full dark annealed state of each sample. Their results indicate that the dominant defect creation mechanism is not Si-Si bond breaking, and also suggests at least two quasi-independent metastable defect creation processes. 10 references, 5 figures, 2 tables.

20219 (SERI/CP—211-3086, pp 201-210) **Theoretical investigations of the light-induced effects in hydrogenated amorphous silicon.** Adler, D. (Massachusetts Institute of Technology, Cambridge). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

The light-induced effects in hydrogenated amorphous silicon (a-Si:H) are briefly described, and the two classes of models for their origin summarized. A wide array of recent theoretical calculations that have been performed to elucidate the microscopic and macroscopic mechanisms for light-induced changes are described in detail. Although the basic origin of the effects are still in doubt and may be quite complex, there is presently a great deal of theoretical and experimental evidence in favor of the existence of large concentrations of charged centers in all a-Si:H samples. 24 references, 4 figures.

20220 (SERI/CP—211-3086, pp 213-222) **Structural and electronic studies of defects in amorphous silicon.** Street, R.A. (Xerox Palo Alto Research Center, CA). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

Recent research conducted by the authors has found that a major part of the localized electronic state distribution in hydrogenated amorphous silicon is in thermal equilibrium at elevated temperatures. Measurements have been made of dark D.C. conductivity, and of the density of shallow occupied states, n/sub BT/, using the voltage pulse sweep out technique, with particular emphasis on the effects of annealing and cooling the samples. n/sub BT/ is related to the densities of donors, N/sub DONOR/, and dangling bonds, N/sub DB/. In n-type samples, there is much evidence that electron transfer from donors results in charged dangling bonds. Electrons therefore, occupy the band tail and the overlapping donor states according to the relation n/sub BT/$\approx$N/sub DONOR/-N/sub DB/. The experiments have shown that n/sub BT/ and the conductivity are both time and temperature dependent.

**20221** (SERI/CP—211-3086, pp 225-234) **Electronic processes in thin film PV materials.** Taylor, P.C.; Gal, M.; Williams, G.A.; Ohlsen, W.D. (Univ. of Utah, Salt Lake City). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

This paper reports on a research program designed to characterize the roles of defects and impurities in thin film amorphous semiconductors based on hydrogenated amorphous silicon (a-Si:H). Also discussed are methods to determine the quality of interfaces and junctions which occur in PV devices by employing surface-sensitive optical techniques, along with research aimed at understanding the electronic metastabilities in these amorphous thin films.

**20222** (SERI/CP—211-3086, pp 247-254) **Review of amorphous silicon TFT and integrated image sensor.** Tomiyama, S.; Ozawa, T. (Electronic Imaging and Devices Research Lab., Kanagawa, Japan). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

This review covers a-Si integrated image sensor and a-Si TFT as applied to it and to other imaging devices. The integrated image sensor is an a-Si linear sensors array with scanning, processing and amplifier circuits integrated on the same substrate.

**20223** (SERI/CP—211-3086, pp 261-264) **Progress in continuous processing of amorphous silicon solar cells on polymer substrates.** Jeffrey, F.R. (Electrical and Communications Technologies Lab., St. Paul, MN). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

There are many advantages to be gained by fabricating a-Si solar cells in a continuous manner on flexible plastic web. Most of these are cost factors, although quality control will improve when going from a batch to continuous process. There are also many technical problems that must be solved in dealing with a polymer rather than an inorganic substrate and with the device structure required for substrate system. The paper presented outlines progress in 1986 of a research project which has allowed for major improvements in device performance for cells fabricated on continuous polyimide substrates.

**20224** (SERI/CP—211-3086, pp 267-277) **Development of high efficiency single junction amorphous silicon solar cells and submodules.** Kampas, F.J.; Delahoy, A.E.; Eser, E.; Volltrauer, H.; Weakliem, H.; Kiss, Z. (Chronar Corp., Princeton, NJ). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

Research at Chronar aimed at developing stable, high efficiency amorphous silicon solar cells and submodules is discussed. The research deals primarily with deposition of the semiconductor and non-semiconductor components and the stability of the completed cells and submodules.

**20225** (SERI/CP—211-3086, pp 281-287) **Development of high performance large-area amorphous silicon solar cells.** Carlson, D.E.; Arya, R.R.; Bennett, M.S.; Catalano, A.; D'Aiello, R.V.; Dickson, C.R.; Newton, J.L.; Oswald, R.S. (Solarex Thin Film Div., Newtown, PA). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

Recent developments in a-Si solar cell technology at Solarex have led to conversion efficiencies as high as 10.9% for p-i-n cells with superlattice doped layers and efficiencies as high as 8.7% for the 1000 $cm^2$ submodules. The development of laser scribing for patterning of large-area submodules has led to both high performance and high yields.

**20226** (SERI/CP—211-3086, pp 295-303) **Current status of multijunction devices fabricated from fluorinated amorphous silicon-based alloys.** Yang, J. (Energy Conversion Devices, Inc., Troy, MI). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

High efficiency multijunction devices fabricated by Energy Conversion Devices, Inc. are discussed. The devices have excellent stability because of the use of fluorinated amorphous silicon-based alloys. Data, based on outdoor tests. are presented to show the devices outperform single junction devices.

**20227** (SERI/CP—211-3086, pp 307-315) **GSI's continuous multichamber approach for mass production of amorphous silicon solar cells.** Madan, A. (Glasstech Solar, Inc., Wheatridge, CO). Jan 1987. NTIS, PC A 14. File Number DE87001120. (CONF-870115—).

From Amorphous silicon subcontractors' review meeting; Palo Alto, CA, USA (26 Jan 1987).

The research activities of Glasstech Solar, Inc. (GSI) in developing high quality a-Si:H type materials are discussed. GSI has designed, built, and delivered amorphous silicon deposition systems ranging from single chamber research systems to multichamber research systems to prototype production systems capable of handling a minimum of 30 cm x 30 cm substrates to complete photovoltaic turnkey plants. In the paper presented, the world's first continuous mass production system with glass in-panel out approach for the inexpensive fabrication of amorphous silicon solar cells is described.

**20228** **Glow-discharge-implanted, thermally annealed, oxide-passivated silicon solar cells of 19% efficiency.** Westbrook, R.D.; Wood, R.F.; Jellison G.E. Jr. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Applied Physics Letters;* **50**: No. 8, 469-471(23 Feb 1987). Contract AC05-84OR21400.

Single-crystal silicon solar cells with efficiencies as high as 19.3% AM1.5 have been fabricated using simple, glow-discharge ion implantation followed by conventional furnace annealing during which an oxide layer was grown for surface passivation. Fine-line (—5 $\mu$m) photolithography was used for metallization to reduce carrier recombination at the metal-silicon interface and optimized ZnS/$MgF_2$ antireflection coatings were applied. The efficiencies of these cells are the highest reported to date for ion-implanted cells.

**20229** **Advanced materials and device analytical techniques.** Kazmerski, L.L. (Solar Energy Research Center, Golden, CO). pp 1-123 of Advances in solar energy, Vol. 3. Boer, K.W. New York, NY; Plenum Press (1986).

The analytical approaches discussed in this chapter are categorized into three major areas: volume analysis, energy dispersive spectroscopy and wavelength dispersive spectroscopy, and microelectrical characterization. Electron-beam induced-current and voltage techniques are described. The applications are chosen to illustrate both the utility and the weaknesses of these analytical approaches. The range of analytical tools useful to the solar technologies is expansive. This chapter introduces some of the more utilized (and perhaps more sophisticated) characterization techniques, focusing primarily on those in the compositional, chemical and microelectrical areas. The intent is to provide some understanding of

the fundamental principles or physics of each of these methods, their instrumentation, their limitations and their strengths, and the applications to technology development.

**20230 New technologies in the production of woody crops for energy in the U.S.** Ranney, J.W. (Oak Ridge National Lab., Oak Ridge, TN). pp 387-438 of Advances in solar energy, Vol. 3. Boer, K.W. New York, NY; Plenum Press (1986).

The search for significant amounts of renewable energy from woody plants has resulted in the development of new technologies in forest utilization and harvesting, in cultivation of tree crops specifically for energy, and in the genetic selection of woody plants for energy feedstocks. This chapter addresses these developments with primary emphasis on cultivation and genetic selection that result in woody plants being more competitive as an energy feedstock. The existing and projected wood inventories in the United States are described. A discussion of the developments in the production of wood energy feedstocks is the central issue and the main focus of this chapter. Specifically, the culture, genetics, physiology, harvesting, and economics of short-rotation intensive culture in North America are discussed.

**20231 Current Topics in Photovoltaics.** Coutts, T.J.; Meakin, J.D. (eds.). London, England; Academic Press (1985). 279p.

The first volume of 'Current Topics in Photovoltaics' contains five chapters which review different types of solar cells. These include heterojunction solar cells, Cu-ternary chalcopyrite solar cells, amorphous silicon solar cells, advanced concentrator solar cells and cadmium sulphide - copper sulphide solar cells. All five chapters were selected and indexed separately.

**20232 Heterojunction solar cells. Chapter 1.** Fonash, S.J.; Rothwarf, A. (Pennsylvania State Univ., University Park, USA. Coll. of Engineering; Drexel Univ., Philadelphia, PA, USA. Dept. of Electrical and Computer Engineering; Solar Energy Research Inst., Golden, CO, USA; Delaware Univ., Newark, USA. Inst. of Energy Conversion). pp 1-39 of Current topics in photovoltaics. Coutts, T.J.; Meakin, J.D. (eds.). London, England; Academic Press (1985).

A review is given of heterojunction solar cells for use in photovoltaic applications. After describing the concept, the advantages and disadvantages of these solar cells are discussed. The wide range of possible heterojunction configurations and parameters permits great flexibility in choice of materials and cell structures; specific examples are given.

**20233 Cu-ternary chalcopyrite solar cells. Chapter 2.** Kazmerski, L.L.; Wagner, S. (Solar Energy Research Inst., Golden, CO, USA; Princeton University, New Jersey, USA. Department of Electrical Engineering and Computer Science; Solar Energy Research Inst., Golden, CO, USA; Delaware Univ., Newark, USA. Inst. of Energy Conversion). pp 41-109 of Current topics in photovoltaics. Coutts, T.J.; Meakin, J.D. (eds.). London, England; Academic Press (1985).

A review is given of Cu-ternary solar cells, emphasizing the (CdZn)S/$CuInSe_2$ device. The structure, composition and electrooptical properties of $CuInS_2$, $CuInSe_2$ and $CuInTe_2$ are covered. Photovoltaic device structures and performance are reviewed and materials properties are summarized. The formation and development of the heterostructure and other junctions in the CdS/$CuInSe_2$ device are presented. Surface analyses and correlated microelectrical characterization results are reported, dealing with the electrical activity and composition of this device. Finally the future of these devices is discussed in terms of cost-effectiveness and overall performance.

**20234 Advanced concentrator solar cells. Chapter 4.** Fraas, L.M. (Chevron Research Co., Richmond, CA, USA; Solar Energy Research Inst., Golden, CO, USA; Delaware Univ., Newark, USA. Inst. of Energy Conversion). pp 169-221 of Current topics in photovoltaics. Coutts, T.J.; Meakin, J.D. (eds.). London, England; Academic Press (1985).

Recent work on advanced, high efficiency, concentrator solar cells is reviewed. After describing the historical development of such cells, some general aspects of performance are discussed. The status of the current research efforts directed towards pushing efficiencies over 30% is described. Finally, the high efficiency cell work is placed in the context of current concentrating photovoltaic array development.

**20235 New generation photovoltaic technologies.** Surek, T.; Mc Connell, R.D. (Solar Energy Research Institute, 1617 Cole Boulevard, Golden, CO 80401). pp 1563-1567 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—). Contract AC02-83CH10093.

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

Five generations of photovoltaic technologies are identified: single crystal silicon, polycrystalline silicon, ribbon silicon, single-junction thin films, and multijunction thin films. The Solar Energy Research Institute (SERI) is the focus for the U.S. government's research and development of the most promising, the fourth and fifth generation single-junction and multijunction thin films. Improvements in materials and solar cell fabrication techniques have resulted in remarkable progress for thin-film devices in recent years. This paper describes some recent highlights of SERI's photovoltaic research efforts.

**20236 Back surface field solar cells: A sensitivity study of design parameters.** Lin, E.I.H. (Jet Propulsion Lab., California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109). pp 1573-1577 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

Sensitivity analyses were conducted for key design parameters of back-surface-field solar cells, using a one-dimensional device model SPCOLAY. Quantitative results obtained reveal several design guides to help make back surface field useful in mid-to-high bulk resistivity cells.

**20237 Effects of area increase on photovoltaic cell performance and processing.** Burger, D.R. (Jet Propulsion Lab., California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109). pp 1583-1587 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

An area of high efficiency photovoltaic (PV) cell research that has been generally overlooked is the effects of scale up. An increase in PV cell size causes change in cell performance, available processing options and expected process yield. An analysis is presented to alert technologists to the nature and, where possible, the magnitude of these changes.

**20238 The influence of terrestrial solar spectra on the performance of selected single and multijunction solar cells.** Riordan, C.; Bird, R.; Hulstrom, R.; Cole, L.; Mc Connell, R. (Solar Energy Research Institute, 1617 Cole Boulevard, Golden, CO 80401). pp 1588-1592 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper describes a model that predicts hourly and daily efficiencies and power output of single and multibandgap solar cells as a function of spectral irradiance. Since spectral irradiance varies with sun angle and atmospheric conditions, this model is useful for studying the performance of various solar cells at different times and locations. Preliminary results are given for one-to-three bandgap amorphous silicon cells with series or independent connection.

20239 **Potential health and safety hazards associated with the manufacture of amorphous silicon and copper indium diselenide photovoltaic cells.** Fthenakis, V.M.; Moskowitz, P.D.; Hamilton, L.D. (Biomedical and Environmental Assessment Div., Brookhaven National Lab., Upton, NY 11973). pp 2341-2345 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

Heath and safety hazards in production of α-Si and CuInSe/ sub 2/ photovoltaic cells are identified and characterized for their potential to cause health effects. The most significant potential hazards are associated with toxic and explosive gases, high voltages, and rf radiation. These hazards are not unique to the photovoltaic industry; various control options can be used to reduce or eliminate them.

20240 **State of the art in bioconversion.** Lipinsky, E.S. (Battelle, Columbus Div., 505 King Avenue, Columbus, OH 43201). pp 1789-1793 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper proposes that bioconversion of solar energy into useful products is not a single technology. It is a sprawling conglomeration of diverse technologies. Bioconversion normally is narrowly defined in terms of energy production. Solar energy-initiated bioconversion yields not only products but also materials and foods. The author calls for integration of fuels from biomass systems with foods, chemicals, and materials systems. He believes that this integration would be a move in the right direction.

20241 **Resource evaluation and site selection for bioenergy production systems.** Maxwell, E.L.; Folger, A.G. (Solar Energy Research Institute, 1617 Cole Boulevard, Golden, CO 80401). pp 2538-2542 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

Bioenergy production requires land, water, and nutrient resources and must be undertaken under climatic conditions suitable for plant growth. Therefore, the production and use of biomass for energy must compete with production for other uses such as food, clothing, lumber, and paper. Our land and water resources are also in demand for transportation, mineral extraction, industry, recreation, wildlife, and housing development. Climate, land, and water resource requirements of microalgae production systems (MPS) were examined relative to construction costs, operating costs, and biomass productivity. Maps of climate, land, and saline groundwater resource parameters for the southwestern United States were transformed into digital overlays permitting cell by cell compositing to form maps indicating relative suitability for microalgae production.

20242 **Photosynthesis and biomimetic systems.** Norris, J.R.; Bolton, J.R. (Argonne National Lab.). pp 2625-2626 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper discusses artificial photosynthesis. Topics considered include energy source development, efficiency, service life, biochemical reaction kinetics, solar cells, simulation, mathematical models, performance, and service life.

## 1406 Photovoltaic Power Systems

*REFER ALSO TO CITATION(S) 20179*

20243 **(SAND—87-7004) Characterization of intermediate-sized photovoltaic system designs.** Noel, G.T.; Ayres, J.G. (Battelle Columbus Labs., OH (USA); Kellam and Johnson, Inc., Columbus, OH (USA); Sandia National Labs., Albuquerque, NM (USA)). Jan 1987. Contract AC04-76DP00789. 201p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE87005974.

Detailed descriptions of the designs and current hardware of nine intermediate- to large-sized DOE-funded photovoltaic projects are presented. For each site, a narrative description is accompanied by a photograph of the array field and a line diagram illustrating key design features and hardware. The systems described are Beverly High School, Dallas-Ft. Worth Airport, Georgetown University, Lovington Shopping Center, Natural Bridges National Monument, Newman Power Station, Oklahoma City Omniplex, Phoenix Sky Harbor Airport, and WBNO Radio Station.

20244 **Flat-plate versus concentrator photovoltaic systems - Comparative insolation, energy production and economic analysis.** Herwig, L.O. (Photovoltaic Energy Technology Div., U.S. Dept. of Energy, Washington, DC 20585). pp 1644-1648 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

Flat-plate and concentrator photovoltaic energy systems are analyzed to compare their relative effectiveness in the utilization of the incident radiation at a variety of U.S. locations, the conversion of the incoming radiation to electrical energy and the cost of the electricity delivered at the busbar. This comparative study is limited to three types of flat-plate systems--two-axis tracking, one-axis tracking and fixed-latitude-tilt systems--and one type of concentrator system--two-axis tracking for point-focus Fresnel lens system. The analysis shows that concentrator systems in the best insolation sites (such as the southwest, in general, and Phoenix, Arizona, in this analysis) may provide substantially lower-cost delivered electric power than flat-plate fixed-latitude-tilt systems or two-axis tracking systems. In many other above average insolation areas, such as Atlanta, Georgia, the cost of delivered power among these systems appears to be about the same.

20245 **Photovoltaic concentrator array evaluation.** Maish, A.B. (Sandia National Labs., Div. 6224, Albuquerque, NM 87185). pp 1649-1653 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

Photovoltaic (PV) concentrator arrays are tested at the Sandia PV test facility in order to characterize the performance of the array subsystems during baseline tests and to evaluate array performance during extended operation. Array testing is designed to evaluate the complete array system (modules, structure, drives, and tracking controls) following module development and qualification testing and preceding full field tests. The major baseline tests characterize array electrical and thermal efficiency, sensitivity to tracking errors, full day tracking accuracy and array power requirements.

20246 **Predicting field performance of photovoltaic modules from accelerated thermal and ultraviolet aging data.** Gonzalez, C.C.; Liang, R.; Ross, R.G. Jr. (Jet Propulsion Lab., 4800 Oak Grove Dr., Pasadena, CA 91109). pp 1775-1779 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

A 30-year lifetime for photovoltaic (PV) modules is necessary for such applications as central-station power generation. A key to the achievement of this target is an understanding of the failure mechanisms related to aging-induced degradation of materials in field environments, including the ability to forecast long-term effects of exposure to high temperature and ultraviolet (UV) light. Some results of a research program at the Jet Propulsion Laboratory, aimed at characterizing aging mechanisms in polymeric PV encapsulant materials, are described. The development of an analytical structure for assessing the significance of thermal-UV-induced transmission losses in ethylene vinyl acetate in simulated 30-year field exposure at various U.S. sites is discussed.

## 1407 Solar Thermal Power Systems

**20247 (DOE/NASA/33408—1) Advanced Stirling conversion systems for terrestrial applications.** Shaltens, R.K. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1987. Contract AT04-85AL33408. 25p. (NASA-TM—88897; CONF-870307—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004216.

From ASME/JSME/ISES solar energy conference; Honolulu, HI, USA (22 Mar 1987).

Sandia National Laboratories (SNLA) is developing heat engines for terrestrial Solar distributed Heat Receivers. SNLA has identified the Stirling to be one of the most promising candidates for the terrestrial applications. The free-piston Stirling engine (FPSE) has the potential to meet the DOE goals for both performance and cost. Free-piston Stirling activities which are directed toward a dynamic power source for the space application are being conducted. Space power system requirements include high efficiency, very long life, high reliability and low vibration. The FPSE has the potential for future high power space conversion systems, either solar or nuclear powered. Generic free-piston technology is currently being developed for use with a residential heat pump under an Interagency Agreement. Also, an overview is presented of proposed conceptual designs for the Advanced Stirling Conversion System (ASCS) using a free-piston Stirling engine and a liquid metal heat pipe receiver. Power extraction includes both a linear alternator and hydraulic output capable of delivering approximately 25 kW of electrical power to the electric utility grid. Target cost of the engine/alternator is 300 dollars per kilowatt at a manufacturing rate of 10,000 units per year. The design life of the ASCS is 60,000 h (30 y) with an engine overhaul at 40,000 h (20 y). Also discussed are the key features and characteristics of the ASCS conceptual designs.

**20248 (SERI/CP—252-2714) Proceedings: Workshop on solar applications of energy conversion technology.** (Solar Energy Research Inst., Golden, CO (USA)). Aug 1986. Contract AC02-83CH10093. 265p. (CONF-8502145—). NTIS, PC A12/MF A01; 1; GPO Dep. File Number DE86014506.

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

The workshop described in this document was sponsored by the US Department of Energy's Solar Thermal Technology Program. The goal of this program is to advance the engineering and scientific understanding of solar thermal technology and to establish the technology base from which private industry can develop solar thermal power production options for introduction into the competitive energy market. Each paper has been separately indexed for inclusion in the Energy Data Base.

**20249 (SERI/TP—252-2976) Analytical model of an irrigated packed-bed direct-contact heat exchanger at high temperature.** Bohn, M.S. (Solar Energy Research Inst., Golden, CO (USA)). Nov 1986. Contract AC02-83CH10093. 10p. (CONF-870307—17). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001119.

From ASME/JSME/ISES solar energy conference; Honolulu, HI, USA (22 Mar 1987).

This paper presents an analytical model of direct-contact heat exchange (DCHX) in an irrigated packed bed at high temperatures. The specific application is heat exchange between molten salt and air where the molten salt is a sensible heat storage medium and high temperature air is required for an end process. The model defines several heat transfer mechanisms between the three components in the bed - the liquid, the gas, and the packing. It also includes the effect of conduction in the packing. Correlations found in the literature are used to calculate the associated heat transfer coefficients. The model is restricted to liquids that wet the packing material and to gas/liquid flow rates below the loading point. Three dimensionless equations describe the heat balance between the three bed components. The resulting dimensionless parameters reveal that for commercial DCHX systems, radiation heat transfer is unimportant relative to the convective heat transfer, which is consistent with previous experimental results for air/mercury and nitrogen/molten lead systems. The model also predicts volumetric heat transfer coefficients of about 10,000 $W/m^3K$, which is consistent with experimental work.

**20250 Current status and future needs in solar thermal power systems.** Gupta, B.; Geyer, M. (Solar Energy Research Institute). pp 2417-2619 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper examines central receiver power plants. Topics considered include cooling systems, performance, molten salts, heliostats, meteorology, standardized terminology, risk assessment, and site selection.

## 1408 Ocean Energy Systems

**20251 Measurements of gas sorption from seawater and the influence of gas release on open-cycle ocean thermal energy conversion (OC-OTEC) system performance.** Penney, T.R.; Althof, J.A. (Solar Energy Research Institute, 1617 Cole Boulevard, Golden, CO 80401). pp 1526-1530 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

The technical community has questioned the validity and cost-effectiveness of open-cycle ocean thermal energy conversion (OC-OTEC) systems because of the unknown effect of noncondensable gas on heat exchanger performance and the power needed to run vacuum equipment to remove this gas. To date, studies of seawater gas desorption have not been prototypical for system level analysis. This study gives preliminary gas desorption data on a vertical spout, direct contact evaporator and multiple condenser geometries. Results indicate that dissolved gas can be substantially removed before the seawater enters the heat exchange process, reducing the uncertainty and effect of inert gas on heat exchanger performance.

## 1409 Solar Thermal Utilization

*REFER ALSO TO CITATION(S) 20172, 20489*

**20252 (ETSU-S—1110D) Passive solar design in non-domestic buildings.** Duncan, I.P.; Hawkes, D. (UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; Department of Energy, London (UK)). Jun 1983. 212p. British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

A report is given of a broad assessment of the potential contribution which passive solar design might make in reducing the energy needs of both new and existing non-domestic buildings in the UK. The report is divided into 5 main sections dealing with the principles of passive solar design, the building types in the non-domestic building sector, passive design practice, economic aspects and finally the potential for energy savings from passive solar design applications.

20253 (UK-ISES—C40) **Solar energy and building design. Workshop proceedings.** Jesch, L.F. (ed.). (International Solar Energy Society, London (UK). UK Section). 11 Apr 1985. 110p. (CONF-8504294—). British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

The workshop proceedings presented cover revision of the BS 5918 Code of Practice, thermosyphon air system and solar energy water heaters, passive solar energy programmes and system components, solar rehabilitation of an ancient building, Swedish solar heating programme, European Community demonstration projects, simulations and control strategies. Phase change solar energy storage, estimation of diffuse radiation from meteorological data, weather models, energy analysis, computing heating loads and evaluating indoor comfort and a bioclimatic building design are described.

20254 (UK-ISES—C40, pp 3-7) **System performance for revision of BS 5918:1980.** Brinkworth, B.J. (University College, Cardiff, GB. Solar Energy Unit; University of Birmingham, GB. Solar Energy Laboratory). 11 Apr 1985. British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

The revision of the BS 5918 Code of Practice for the solar heating of domestic hot water with an improved performance prediction procedure, is discussed. The performance calculations were made by full dynamic simulations carried out independently at two different centres. The results given in the Code were for systems having south-facing collectors with 45° slope, located at Kew. Methods for correcting the reference performance predictions for a wide variety of design and operational factors are given in the Code.

20255 (UK-ISES—C40, pp 8-16) **Barra Thermosyphon Air System: Residential and agricultural applications both in Italy and in the UK.** Barra, O.A.; Franceschi, L. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

The Barra Thermosyphon Air System is a passive solar system suitable for single and multi-storey residential, agricultural and industrial buildings. It was conceived, modelled and set up in the 1970's as an evolution of the Trombe wall. As such it was supposed to overcome most of its limits. The Barra system was installed in over 100 houses throughout the world. The applications include an office block in the Egyptian Sahara desert where the system is used for cooling purposes. The main elements of the system are storage and air ducts in the ceiling, and insulated solar chimney on the south facade. The typical characteristics of the system are the thermal isolation of the building from the collector, nil storage heat losses and the high turbulence in the chimney.

20256 (UK-ISES—C40, pp 17-21) **Data-acquisition from thermosyphon solar-energy water heaters for a terrace of three dwellings.** Norton, B.; Fleming, P.D.; Lo, S.N.G.; Probert, S.D.; Wilson, H.G.W. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

Three thermosyphon solar-energy water heaters were retrofitted to a terrace of three dwellings. The times required for each stage of the installation procedure are presented. A microcomputer-based data-acquisition system is employed to monitor the performances of each of the units. The main features of this system are outlined. The software, which was specially developed for this application, is described.

20257 (UK-ISES—C40, pp 22-26) **Architect's view of the CEC Passive Solar Programme.** Clarke, D. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

A brief resume of the content of the CEC work, is given and experience of demonstration projects gained and difficulties encountered are discussed. The Rowheath solar village CEG demonstration project is described.

20258 (UK-ISES—C40, pp 27-33) **Review of components for passive solar energy utilization.** Goetzberger, A.; Schmid, J. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

The potential for energy savings of up to 50% existing in the space heating sector is discussed and a number of measures being tested or applied in building construction, e.g. improvement of heating and control techniques, better heat insulation, active use of regenerative energy sources and passive use of solar energy are considered. A survey of the present status of components for passive solar energy utilization with particular emphasis on central European conditions is given.

20259 (UK-ISES—C40, pp 34-38) **Solar rehabilitation in urban area.** Dewint, A. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

The conversion of a condemned building into office and housing units is considered and the aims to estimate the economic viability of the project and to show that the quality of early century Brussels architecture is compatible with energy savings and passive solar systems are outlined. The study organisation, proposed solution and solar collectors are described.

20260 (UK-ISES—C40, pp 39-43) **Evaluation of the Swedish solar heating programme 1977-1984.** Oefverholm, E. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

The Swedish Council for Building Research's program is reviewed and its earlier commitments to solar heating technology aimed at testing many different types of systems such as ground heat stores, water heat stores with or without heat pumps and low-temperature, medium-temperature and high-temperature solar collectors are stated. The main objective in the 1980's was to reduce costs and increase the performance of those types of systems that were regarded as having the most promise. Another objective was to develop systems that could be connected to existing buildings and built environments. Most of the work carried out during the 1980s has been devoted to domestic hot water solar heating systems, large installations with seasonal heat stores and solar collector arrays connected directly to group heating plants and district heating systems.

20261 (UK-ISES—C40, pp 50-53) **Simulation of four passive direct gain solar houses in Birmingham by the F-chart method.** Fellague, K. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

General design methods for passive solar heating are needed to evaluate the effects of design parameters on building energy needs. The direct gain system is considered as a building with a window through which radiation is admitted and stored in the building mass. A general design method is used and the effect of house capacitance examined.

20262 (UK-ISES—C40, pp 54-59) **Control strategies and devices for active solar heating.** Jankovic, L. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

In order to provide better solar heating system performance, radiation control strategies and variable flowrates through the collector were explored. Numerous simulations were made for a variable volume storage system and the results implied that a function exists which determines the variable flowrate under constantly changing instantaneous solar radiation. Based on the simulation results, a radiation control system was built with an electronic board designed, developed and tested.

20263 (UK-ISES—C40, pp 69-73) **Further development of the Cardiff Solar Energy Unit's design method.** Lloyd, P.B.; Marshall, R.H. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

A simplified prediction method has been developed at the Solar Energy Unit, Cardiff, for the rapid assessment of the thermal performance of solar-heating systems. This method treats three distinct cases: the open-loop case, as in domestic hot-water heating (DWH): the closed-loop case, as in space heating (SH); and a hybrid case, namely combined DHW and SH. Extensions of the method include heat losses from pipework in the collector loop, energy gains by the heat-transfer fluid from the mechanical action of pumps, and the inclusion of a heat-exchanger between the store and the load loop are outlined.

20264 (UK-ISES—C40, pp 85-89) **Microcomputer tool for solar house design.** Szokolay, S.V. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

A micro computer tool is proposed, based on the gradual method, of which the first two parts PREDA (pre-design analysis) and QUBAL (heat flow balance) methods are presented. Later stages of the gradual method include several established evaluative tools. The emphasis is laid on the first two stages of the design process: if these are successful, no radical changes will be necessary at the later evaluative stages, therefore much time and effort can be saved and a better design is likely to result.

20265 (UK-ISES—C40, pp 90-95) **Method 5000: A method for computing heating loads and evaluating indoor comfort in passive solar houses.** Raoust, M. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

A method designed in France for the computation of monthly heating loads in houses and the evaluation of indoor comfort is described. The method is certified for French building regulations and recommended by the CEC Passive Solar Modelling Group. Both the manual method and the computer software are discussed.

20266 (UK-ISES—C40, pp 96-101) **Simulation of solar systems.** Clarke, J.A. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

ESP is a transient energy simulation system capable of modelling the energy and mass flows within buildings and the energy flows within plant systems. Any building, defined as a collection of interlocking polyhedral zones, specified in terms of geometry, construction and usage profiles, can be associated with a plant system consisting of a distributed network of plant components. The combined system can then be subjected to simulation processing under dynamic control. ESP is as applicable to existing buildings as it is to proposed new designs incorporating traditional or advanced technological features.

20267 (UK-ISES—C40, pp 102-104) **Passive solar research and development in Europe.** Lebens, R.M. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

The review presented covers research and development achievements, and the goal to see passive solar design as an integral part of the total architectural design process, a research team consisting of designer, building scientist and quantity surveyor, and international cooperation and interaction.

20268 (UK-ISES—C40, pp 105-109) **Bioclimatic building design for Porto Santo, Madeira.** Schreck, H. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

On the Portuguese island of Porto Santo, north-east of Madeira, there is being built a solar seawater desalination plant including a lab and studio building, developed according to the aspects of bioclimatic and energy conscious design. The Passive Solar Building is described and energy conscious architecture, energy and water supply, design conception and operation in summer and winter outlined.

20269 **Capacity degradation of field tested silica gel samples.** Penney, T.R.; Pesaran, A.A.; Thomas, T.M. (Solar Energy Research Institute, 1617 Cole Boulevard, Golden, CO 80401). pp 689-693 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

Researchers at the Solar Energy Research Institute (SERI) have begun preliminary studies to quantify the effect of contamination of silica gel used in dehumidification processes of desiccant cooling systems. Sorption capacity degradation of field tested samples were measured, and the source of degradation was quantified using surface analysis experimental methods.

20270 **Closing the gap between active and passive solar heating.** Balcomb, J.D. (Los Alamos National Lab., Los Alamos, NM 87545). pp 41-55 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

The gap between active and passive solar could hardly be wider. The reasons for this are discussed and advantages to narrowing the gap are analyzed. Ten years of experience in both active and passive systems are reviewed, including costs, frequent problems, performance prediction, performance modeling, monitoring, and cooling concerns. Trends are analyzed, both for solar space heating and for service water heating. A tendency for the active and passive technologies to be converging is observed. Several recommendations for narrowing the gap are presented.

20271 **Results of design tool evaluations for passive solar design.** Rittelmann, P.R.; Ahmed, S.F. (Burt Hill Kosar Rittelmann Associates, 400 Morgan Center, Butler, PA 16001). pp 374-378 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

The results of design tool evaluations performed as part of the International Energy Agency (IEA) Task VIII Subtask "C" activities are presented. Four building types, with three passive solar features each, were evaluated for three cities. The results of the evaluation are presented. Detailed results are presented for a few cases. Further work, required to investigate discrepancies between predictions of design tools and standard comparison SERI-RES, is

listed. Possible reasons for lack of agreement between design tools are given.

**20272 A self-pumping vapor system for hybrid space heating.** Neeper, D.A.; Hedstrom, J.C. (MS J 576, Los Alamos National Lab., Los Alamos, NM 87545). pp 440-444 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper reports investigations of a passive system that transports heat from a solar collector downward. Refrigerant is evaporated in a collector and the vapor transports heat to one or more condensers located at an arbitrary elevation below the collector. The vapor pressure lifts the condensed liquid to an accumulator located near the top of the collector. The results of annual performance calculations are presented for a space heating application in which one or more condensers are located within passive thermal storage units that release heat directly to one or more zones of the building. Simple sizing rules for optimal energy yield are given.

**20273 Performance evaluation of a hybrid solar heating system having a radiant panel slab.** Starr, R. (The Solar Option One Co., Lyndonville, VT 05851). pp 461-465 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper summarizes the results of performance monitoring of a simple hybrid solar heating system of the active charge/passive discharge type. Conventional active hydronic flat plate solar collectors charge a massive radiant panel slab. Solar energy is stored and released to the building in a passive manner by radiation and conduction. The performance monitoring has demonstrated that this simple low cost hybrid solar heating system offers significant advantages in system efficiency, overall performance, comfort and architectural flexibility.

**20274 Solar collector/regenerator performance based on experimental heat and mass transfer correlations.** Novak, K.S.; Wood, B.D. (Center for Energy Systems Research and Mechanical and Aerospace Engineering, Arizona State Univ., Tempe, AZ 85287). pp 669-673 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

One of the most promising concepts for economical solar cooling is the open cycle absorption refrigeration (OCAR) system. In the OCAR system, a solar collector/regenerator (C/R) is used to concentrate a liquid absorbent solution by evaporating water to the atmosphere. This research utilizes a C/R model based on experimentally determined heat and mass transfer correlations. The validated computer model is used to test the effects of various climatic, operational and collector design variables on evaporation rate.

**20275 Thermal performance comparisons for solar hot water systems subjected to various collector array flow rates.** Fanney, A.H.; Klein, S.A. (Solar Equipment Group, National Bureau of Standards, Gaithersburg, MD 20899). pp 538-543 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

The thermal performance of solar domestic hot water (SDHW) systems is influenced by the solar collector array flow rate. An experimental investigation has been conducted at the National Bureau of Standards to quantitatively evaluate this effect. This paper describes the selection of the optimum collector array flow rate based on both analytical and experimental considerations, describes the experimental apparatus, and presents data which illustrates the increase in thermal performance possible by utilizing the optimal flow rate. Computer simulations were performed using TRNSYS to check the consistency of the experimental data, to validate the TRNSYS model for reduced flow rate conditions, and to determine if the performance improvements due to reduced collector flow rate observed during short-term tests could be expected to occur on an annual basis.

**20276 Open-cycle solar absorption cooling.** Lenz, T.; Lof, G.; Kaushik, V.; Sandell, G. (Colorado State Univ., Fort Collins, CO 80523). pp 654-658 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

In this study, a complete open-cycle absorption cooling system was assembled and tested. The subsystems included a packed bed regenerator and a modified Carrier Corporation absorber/evaporator. Successful coupled operation of the entire system was achieved, utilizing the CSU Solar House II air collectors. Chilled water (10°C) has been produced in this system at a rate equivalent to 2.7 refrigeration tons (9.5 kW).

**20277 Mapping the energy saving potential of passive heating combined with conservation.** Balcomb, J.D. (Los Alamos National Lab., Los Alamos, NM 87545). pp 2533-2537 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

A procedure is presented for estimating the energy savings potential of combining conservation and passive solar strategies to reduce building heating. General scaling laws are used for costs and the resulting continuous equations are evaluated to find the least life-cycle cost strategy. Results are mapped for the US.

## 1410 Solar Collectors And Concentrators

*REFER ALSO TO CITATION(S) 20244, 20245, 20262, 20651*

**20278 (BNL—38805) Commercialization of BNL design solar collector in India: Phase 1 report.** Wilhelm, W.G.; Mubayi, V. (Brookhaven National Lab., Upton, NY (USA)). Sep 1985. Contract AC02-76CH00016. 31p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006459.

The present market for solar thermal energy technologies in India is almost completely restricted to solar hot water and, in a smaller number, hot air systems. A few projects utilizing concentrating systems for producing steam and/or thermally generated electric power have been carried out but these are restricted to the R and D stage. Similarly, a few projects employing solar space heating have also been done in remote, mountainous areas but these are also at the R and D level. Based on interviews with knowledgeable observers, including officials of DNES/STEC, state "nodal" agencies responsible for implementing solar energy projects in different states, and flat plate collector/hot water systems manufacturers, it has been roughly estimated that between 90 to 95% of the hot water systems installed or under installation have been funded by government programs. This includes systems funded under Central Government programs by DNES and systems installed under State Government projects. The remaining 5 to 10% of the installations are in the private sector and are believed to be mostly small, domestic systems (100 liters per day of hot water at 60°C).

**20279 (INPE—026-RPE/521) Selective surfaces of high performance and low cost solar collectors.** Anhalt, J.; Ferreira, M.A.; Gill, W. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). Nov 1986. 14p. NTIS, PC A02/MF A01.

The deposition of a thin layer of copper oxide II on a copper metal substrate using alkaline solutions of sodium chlorite is one of the most common methods of preparing selective surfaces for solar collectors. Parameters of the process are the substrate cleaning methods, the oxidation bath concentration and temperature, and the immersion time. A factorial experiment yielded an optimum set of conditions that result in solar absortance of 0.87 and an thermal emittance of 0.04. The process developed can be easily upscaled for commercial application.

20280 **(SAND—86-1978C) Effects of low velocity air flow over alumina-silica insulating boards in solar environments.** Maxwell, C.R.; Mulholland, G.P.; Couch, W.A. (Technadyne Engineering Consultants, Inc., Albuquerque, NM (USA); New Mexico State Univ., Las Cruces (USA); Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 7p. (CONF-870307—15). NTIS, PC A02. File Number DE87005067.

From ASME/JSME/ISES solar energy conference; Honolulu, HI, USA (22 Mar 1987).

Results are reported from an experiment designed to determine whether low velocity air flow over insulating boards can increase their survivability in severe solar environments. The experiment was conducted at the Flux Gage Calibration Station located at Sandia National Laboratories' Solar Thermal Test Facility. Preliminary results indicate that the useful life for these boards can be significantly increased by air flowing over the hot surface of the board.

20281 **Aerogel: A transparent insulator for solar applications.** Hunt, A.; Russo, R.; Tewari, P.; Lofftus, K. (Applied Science Div., Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). pp 223-229 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—). Contract AC03-76SF00098.

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

Aerogel is a transparent, low density, insulating material suitable for a variety of solar applications. Significant energy savings can be realized by using aerogel for a window glazing material. Other possible applications include solar collector covers, transparent insulating jackets for direct gain passive solar devices, and situations that require both transparency and good insulation. Because silica aerogel has a low density (2-10% solid), it has a thermal conductivity as low as 0.014 W/m°K without evacuation, and if evacuated, lower than 0.006 W/m°K. It provides a clear view with only slight coloring due to its weak and nearly isotropic scattering of light. This paper describes significant progress made in the past year at our laboratory in the development of aerogel. The authors have improved the transparency, developed new preparation methods using less toxic materials, and initiated successful experiments in drying alcogels at near ambient temperature. Optical transmission, light scattering, and electron microscopy data show that CO/sub 2/ supercritical drying of alcogels produces aerogels similar in quality to those produced by high temperature supercritical drying. These advances make the commercial production of aerogel much more feasible.

20282 **Integrated evacuated CPC's for high temperature solar thermal systems.** Winston, R.; O'Gallagher, J.; Schertz, W. (The Univ. of Chicago, Chicago, IL 60637). pp 1148-1152 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

A new generation of advanced evacuated tube solar collectors capable of delivering efficient high temperature performance without tracking or tilt adjustment is being developed as an alternative to tracking collectors for temperatures up to and even exceeding 250°C. The essence of the design for these new collectors is the integration of moderate levels of nonimaging concentration inside the vacuum tube itself. This protects the reflecting surfaces permanently and allows the use of highly reflecting front surface mirrors with reflectances ≧95%. Previous work has established the superior performance of the concept through the fabrication and long-term testing of a proof of concept prototype. Present work is directed towards the development of a manufacturable unit which will be suitable for the widest possible range of applications. Design alternatives include scaling up of the original prototype from a 5cm to a 10cm diameter tube, the use of an internal shaped metal concentrating reflector, a variety of profile shapes to minimize so-called "gap losses" and accommodate either conventional (flow-through) or heat pipe absorber configurations.

20283 **A laboratory test of wind-mixing in a salt gradient solar pond.** Atkinson, J.F.; Harleman, D.R.F. (Dept. of Civil Engineering, S.U.N.Y. at Buffalo, Buffalo, NY 14260). pp 1215-1219 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

An experiment is described in which wind-induced entrainment was measured in a laboratory tank under strongly stratified double-diffusive conditions to calibrate a numerical model for application to solar ponds. Results showed that there was no effect of double-diffusive stratification and that the entrainment followed approximately an inverse Richardson number relationship. Shear-induced mixing was found to play a strong role in the entrainment process and it is suggested that an effort be made to obtain more data on wind-induced currents in operating solar ponds.

20284 **Analysis of simultaneous heat and mass transfer in soils below solar ponds.** Leboeuf, C.M. (Solar Energy Research Institute, 1617 Cole Boulevard, Golden, CO 80401). pp 1232-1236 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper examines thermal losses from a solar pond to the underlying soil. A model that includes coupled heat and moisture transport in soils and was originally developed for agricultural analysis is extended to solar pond performance analysis. The model describes a physical system in which soil particles and void spaces are assumed to be randomly arranged ellipsoids in a continuous medium of water or air. The general problem reduces to two coupled partial differential equations, one for heat transfer, the other for moisture transport. Using property data for a specific soil, the authors use the model to determine under what conditions the soil will dry in response to the imposed thermal source of the solar pond and to predict the effect the steady-state soil conditions will have on pond performance. Results of this study also apply to other fields in which a heat source is directly coupled to the ground.

20285 **Parabolic Dish Test Site of JPL: History and operating experience.** Selcuk, M.K.; Ross, D.L. (Jet Propulsion Lab., 4800 Oak Grove Drive, Pasadena, CA 91109). pp 1436-1440 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

The Parabolic Dish Test Site (PDTS), located at the JPL Edwards Test Station, Edwards Air Force Base, California, was operational from September 1978 through June 1984. The PDTS was installed and operated for the Department of Energy (DOE) to test point focus solar concentrator systems operating at temperatures up to 1427°C. Four parabolic dish concentrators, steam and air heating receivers, and three types of solar power conversion modules developed under JPL's supervision or independently by the industry were tested. The PDTS was equipped with a computerized data acquisition and processing system. A weather station, where the beam and circumsolar radiation and environmental data were continually monitored, recorded, processed, and distributed to experimenters, was established.

20286 **Maximally concentrating optics for solar electricity generation.** O'Gallagher, J.; Winston, R. (Univ. of Chicago, Chicago, IL 60637). pp 1669-1673 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

A properly designed nonimaging secondary concentrator placed in the focal zone of a primary lens or paraboloidal mirror can concentrate the solar flux by an additional factor of 2 to 15 above that achievable by the primary alone. Such secondary elements belong to the family of phase-space preserving "ideal" concentrators which can be designed to achieve or closely approach the maximum concentration limit imposed by physical conservation laws. Separate experimental programs to develop advanced two stage concentrators for both solar thermal and photovoltaic electricity generation have recently been initiated in our laboratory. The new designs have unique features heretofore unattainable. The first of these designs uses a fresnel lens primary combined with totally internally reflecting Dielectric Compound Hyperbolic Concentrator secondaries. The second is a facetted paraboloidal primary combined with a Compound Parabolic Concentrator (CPC).

### 1420 Heat Storage

*REFER ALSO TO CITATION(S) 20272, 20273*

20287 (UK-ISES—C40, pp 60-64) **Simulation of phase change solar energy storage.** Laing, D. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

Active solar systems using phase change materials (PCM) for energy storage require special simulation treatment to guarantee that the temperature-enthalpy relations of the store are properly accounted for. The simulation compares various systems using 42 combinations of collector and store sizes. Employing an appropriate control strategy gives satisfactory results of comfort conditions and solar fraction in all investigated cases. These results were evaluated by the bin data method and are presented by plots.

## 15 GEOTHERMAL ENERGY

### 1501 Resource Status And Assessment

*REFER ALSO TO CITATION(S) 20297*

20288 **Modeling the natural state of geothermal systems.** Bodvarsson, G.S. (Lawrence Berkeley Lab., CA). *Earth Sciences;* **7**: No. 3, 1, 5-9(Oct-Dec 1984). Contract AC03-76SF00098.

During the past decade, the Earth Sciences Division of Lawrence Berkeley Laboratory has developed a group of computer codes for the modeling of geothermal systems. Before modeling the exploitation of a resource it is essential to have a good understanding of the system in its natural state. Natural-state modeling provides the necessary initial conditions for exploitation modeling and also gives important insight into the natural flow of mass and heat within the system. It is also of great value in testing different hypothetical models of a given geothermal system. This article gives a brief description of some of their natural-state models; these models were developed using the numerical simulators MULKOM (Pruess, 1983) and PT (Bodvarsson, 1982). The Krafla Geothermal Field in Iceland, the Cerro Prieto field in Mexico, and the Heber field in California are described. 10 references, 8 figures.

20289 **Historical use of geothermal resource at Paso Robles.** Campion, L.F. (California Div. of Mines and Geology). *California Geology;* **37**: No. 6, 119-121(Jun 1984).

During the late 1870's, many of California's warm or hot springs were developed as resort spas or tuberculosis sanitariums where guests came for relaxation or to take the treatments. Much literature advertising and extolling the chemical and physical properties of various hot springs has survived from that era. A search of such material and other historic information yields valuable clues to the past character of a particular geothermal area. Areal extent of the resource and changes in flow rates, water quality, temperature, and hot water table elevations can often be discerned from the historical record of a geothermal area. This paper reviews the history of the warm springs at Paso Robles. 9 references.

20290 **Heat transfer in magma in situ.** Dunn, J.C.; Carrigan, C.R.; Wemple, R.P. (Sandia National Labs., Albuquerque, NM). *Science (Washington, D.C.);* **222**: 1231-1233(16 Dec 1983).

Heat transfer rates in a basaltic magma were measured under typical magma chamber conditions and a numerical model of the experiment was used to estimate magma viscosity. The results are of value for assessing methods of thermal energy extraction from magma bodies in the upper crust as well as for modeling the evolutionary track of these systems. 13 references, 3 figures.

### 1502 Geology And Hydrology Of Geothermal Systems

*REFER ALSO TO CITATION(S) 20298*

20291 **(LBL—22720) The effect of $CO_2$ on reservoir behavior for geothermal systems.** Gaulke, S.W. (California Univ., Berkeley (USA)). Dec 1986. Contract AC03-76SF00098. 149p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87006141.

The purpose was to gain an understanding of the effects of non-condensible gases ($CO_2$) in fractured two-phase geothermal systems. A thorough review of previous work on non-condensible gases was carried out. In addition, since the flowing mass fraction of $CO_2$ is strongly controlled by the flowing saturation, the flowing enthalpy literature was also reviewed. Numerical techniques were employed to examine how non-condensible gases ($CO_2$) affect well transients and to determine the value of these effects as tools to evaluate in situ reservoir parameters. Simplified reservoir models were used to define the effects of $CO_2$ in the reservoir and the resulting transient behavior at the feedzones to the well. Furthermore, fracture-matrix interaction was studied in detail to identify the effects of $CO_2$ on recovery and flow patterns within the reservoir. The insight gained from the sensitivity studies for enthalpy and $CO_2$ transients was applied to interpret transient data from well BR21 at the Broadlands geothermal field of New Zealand.

20292 **(LBL—22810) On fluid and heat transfer in deep zones of vapor-dominated geothermal reservoirs.** Pruess, K.; Celati, R.; Calore, C.; Cappetti, G. (Lawrence Berkeley Lab., CA (USA); Istituto Internazionale per le Ricerche Geotermiche, Pisa (Italy); Ente Nazionale per l'Energia Elettrica, Pisa (Italy). National Geothermal Unit). Jan 1987. Contract AC03-76SF00098. 11p. (CONF-870136—5). NTIS, PC A02. File Number DE87006043.

From 12. workshop on geothermal reservoir engineering; Stanford, CA, USA (20 Jan 1987).

Little is known about fluid and heat transfer process, and thermodynamic conditions of formation fluids beneath the main permeable zones of vapor-dominated systems. Temperature data is presented for deep horizons at Larderello, Italy. The data was analyzed with a view to identifying reservoir conditions and processes at depth. Of particular interest were the mechanisms and rates of fluid and heat flow in the natural state and in response to exploitation, and the permeability structure of the reservoir. (ACR)

20293 **Numerical studies of the heat and mass transport in the Cerro Prieto geothermal field, Mexico.** Lippmann, M.J.; Bodvarsson, G.S. (Lawrence Berkeley Lab., CA). *Water Resources Research;* **19**: No. 3, 753-767(Jun 1983). Contract AC03-76SF00098.

Numerical simulation techniques are employed in studies of the natural flow of heat and mass through the Cerro Prieto reservoir, Mexico and of the effects of exploitation on the field's behavior. The reservoir model is a two-dimensional vertical east to west-

southwest cross section, which is based on a recent hydrogeologic model of this geothermal system. The numerical code MULKOM is used in the simulation studies. The steady state pressure and temperature distributions are computed and compared against observed preproduction pressures and temperatures; a reasonable match is obtained. A natural hot water recharge rate of about 1 x $10^{-2}$ kg/s per meter of field length (measured in a north-south direction) is obtained. The model is then used to simulate the behavior of the field during the 1973-1978 production period. The response of the model to fluid extraction agrees to what has been observed in the field or postulated by other authors. There is a decrease in temperatures and pressures in the produced region. No extensive two-phase zone develops in the reservoir because of the strong fluid recharge. Most of the fluid recharging the system comes from colder regions located above and west of the produced reservoir. 34 references, 22 figures, 5 tables.

## 1503 Geothermal Exploration And Exploration Technology

*REFER ALSO TO CITATION(S) 21272*

20294 **(CPL—598-2) Helium surveys: A survey of geothermal prospects, Project DOE geothermal, Mount Spurr, Alaska: Appendix A.** (Chemical Projects Ltd., Toronto, Ontario (Canada)). 2 Oct 1985. Contract FG07-84ID12471. 29p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006177.

During the period of July 30 to August 5, 1985, a helium survey was conducted over geothermal prospects in the Mount Spurr Area, Alaska. 40 soil, 16 mud and 1 spring water sample were collected during this program. The results indicate helium levels slightly higher than background.

20295 **(LBL—22280) Seismic velocity structure and microearthquake source properties at The Geysers, California, geothermal area.** O'Connell, D.R. (California Univ., Berkeley (USA)). Dec 1986. Contract AC03-76SF00098. 214p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE87006170.

The method of progressive hypocenter-velocity inversion has been extended to incorporate S-wave arrival time data and to estimate S-wave velocities in addition to P-wave velocities. S-wave data to progressive inversion does not completely eliminate hypocenter-velocity tradeoffs, but they are substantially reduced. Results of a P and S-wave progressive hypocenter-velocity inversion at The Geysers show that the top of the steam reservoir is clearly defined by a large decrease of V/sub p//V/sub s/ at the condensation zone-production zone contact. The depth interval of maximum steam production coincides with minimum observed V/sub p//V/sub s/, and V/sub p//V/sub s/ increses below the shallow primary production zone suggesting that reservoir rock becomes more fluid saturated. The moment tensor inversion method was applied to three microearthquakes at The Geysers. Estimated principal stress orientations were comparable to those estimated using P-wave first-motions as constraints. Well constrained principal stress orientations were obtained for one event for which the 17 P-first motions could not distinguish between normal-slip and strike-slip mechanisms. The moment tensor estimates of principal stress orientations were obtained using far fewer stations than required for first-motion focal mechanism solutions. The three focal mechanisms obtained here support the hypothesis that focal mechanisms are a function of depth at The Geysers. Progressive inversion as developed here and the moment tensor inversion method provide a complete approach for determining earthquake locations, P and S-wave velocity structure, and earthquake source mechanisms.

20296 **(UAG-R—308) Geothermal energy resource investigations at Mt. Spurr, Alaska.** Turner, D.L.; Wescott, E.M. (eds.). (Alaska Univ., Fairbanks (USA). Geophysical Inst.). Dec 1986. Contract FG07-84ID12471. 115p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87005944.

Spurr volcano is a composite Quaternary cone of largely andesitic composition located on the west side of Cook Inlet about 80 miles west of Anchorage and about 40 miles from the Beluga electrical transmission line. Geologic mapping (Plate 1-1) shows that the present summit depression was produced by a Mt. St. Helens-type sector collapse, rather than by a caldera collapse. Geochronologic and previous tephrachronologic studies show that there has been an active magmatic system at Spurr volcano during the late Pleistocene-to-Holocene time interval that is of critical interest for geothermal energy resource assessment. Major effort was devoted to geochemical and geophysical surveys of the accessible area south of Mt. Spurr, in addition to geologic mapping and geochronologic studies. Many coincident mercury and helium anomalies were found, suggesting the presence of geothermal systems at depth. Extremely large electrical self-potential anomalies were also found, together with extensive zones of low resistivity discovered by our controlled-source audiomagnetotelluric survey. The juxtaposition of all of these different types of anomalies at certain areas on the south slope of Crater Peak indicates the presence of a geothermal system which should be accessible by drilling to about 2000 ft depth. It is also evident that there is a strong volcanic hazard to be evaluated in considering any development on the south side of Mt. Spurr. This hazardous situation may require angle drilling of production wells from safer areas and placement of power generation facilities at a considerable distance from hazardous areas.

## 1505 Economic And Financial Aspects

20297 **(ETSU-R—34) Economic assessment of Hot Dry Rocks as an energy source for the UK .** Shock, R.A.W. (UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.). Aug 1986. 228p. NTIS (US Sales Only), PC A11/MF A01. File Number DE87751359.

A techno-economic appraisal of Hot Dry Rock technology as it might be implemented in the United Kingdom is presented and covers potential use for electricity generation, heat supply and combined heat and power (CHP). In each case the likely cost of the technology is first determined and is then compared with the benefits accruing through replacement of conventional technologies. In a base case the cost of electricity is calculated to be 4.2p $kWh^{-1}$ and, depending on the background economic scenario, this renders HDR generally attractive when compared with projected costs of coal-fired generation but not with nuclear-powered technologies. Uncertainties and influence of geothermal gradients on HDR economics are discussed.

## 1506 Environmental Aspects And Waste Disposal

20298 **Surface ruptures east of Mexicali from the Imperial Valley earthquake of 15 October 1979.** Haar, S.V. (Lawrence Berkeley Lab., CA). *Bulletin of the Seismological Society of America;* **72**: No. 2, 663-668(Apr 1982). Contract W-7405-ENG-48.

The title earthquake registered a local Richter magnitude of 6.6 and 7.0 at Berkeley. The observations described here were made on 16 October. The earthquake caused slumps and fissures along an unimproved road, a crack in a paved highway, shattered curbs of the concrete median strips of another highway, structural damage to an overpass, and cracks and offsets from 1-3 cm in masonry walkways and parking areas. The paper briefly reviews implications of these surface fractures for the projected 30-year geothermal development in the Salton Trough. 10 references, 6 figures.

## 1507 By-products

20299 **(DOE/SF/15799—T11) Chemical behaviour of geothermal silica after precipitation from geothermal fluids with inorganic flocculating agents at the Hawaii Geothermal Project Well-A (HGP-A).** De Carlo, E.H. (Hawaii Univ., Honolulu (USA)). Jan 1987. Contract FG03-85SF15799. 84p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87003991.

The report summarizes the results of experiments dealing with the problem of removal of waste-silica from spent fluids at the experimental power generating facility in the Puna District of the island of Hawaii. Geothermal discharges from HGP-A represent a

mixture of meteoric and seawaters which has reacted at depth with basalts from the Kilauea East Rift Zone under high pressure and temperature. After separation of the steam phase of the geothermal fluid from the liquid phase and a final flashing stage to 100 degrees Celsius and atmospheric pressure, the concentration of the silica increases to approximately 1100 mg/L. This concentration represents five to six times the solubility of amorphous silica in this temperature range. We have evaluated and successfully developed bench scale techniques utilizing adsorptive bubble flotation for the removal of colloidal silica from the spent brine discharge in the temperature range of 60 to 90 degrees C. The methods employed resulted in recovery of up to 90% of the silica present above its amorphous solubility in the experimental temperature range studied.

## 1509 Geothermal Engineering

20300 **(PNL—6157) Calcite solubility in simulated geothermal brines.** Pool, K.H.; Raney, P.J.; Shannon, D.W. (Pacific Northwest Lab., Richland, WA (USA)). Feb 1987. Contract AC06-76RL01830. 33p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006589.

The deposition of scale on geothermal piping surfaces has been recognized as a cause of increased pressure drop and diminished fluid flow. The two most common scales encountered in the geothermal energy field are silica and calcite. The main purpose of this study was to obtain accurate, reliable calcite solubility data in brines similar to natural geothermal brines over the temperature range of most known exploitable geothermal resources. In addition, geothermal fluid equilibrium modeling efforts and data bases can be refined and fine-turned with respect to the commercially important calcite-geothermal fluid stability problem with these data. The effect of sodium chloride and sodium bicarbonate on the solubility of $CaCO_3$ (calcite) in high temperature solutions was measured over the 100 to 300°C temperature range. The brines studied contained 0 to 5 wt % NaCl, 0 to 5 mM $NaHCO_3$, and 0.003 to 0.1 M $CO_2$. The data detailing calcite solubility at various temperatures are presented in tabular, graphical, and regression-equation form for each brine composition tested.

20301 **Nonisothermal well test analysis method.** Tsang, C.F.; Doughty, C. (Lawrence Berkeley Lab., CA). pp 217-223 of ASME/JSME thermal engineering joint conference proceedings. Vol. 2. Mori, Y.; Yang, W.J. (eds.). New York, NY; American Society of Mechanical Engineers ([1987]). Contract AC03-76SF00098.

A new well test method involves injection of hot (or cold) water into a ground water aquifer, or injection of cold water into a geothermal reservoir, while making temperature measurements at various depths in two or more observation wells. Properties of the aquifer determined include the permeability anisotropy, layering in the aquifer, and in-situ thermal properties. The method has been applied to analyze recent field data from Mobile, Alabama, with satisfactory results. 7 references, 8 figures.

## 1520 Geothermal Data And Theory

*REFER ALSO TO CITATION(S) 20291, 20300*

20302 (DOE/ER/60152—1-Pt.2, pp 804) **Stable isotopes of hydrogen and oxygen and the origin of geothermal waters in north China.** Guiru, L.; Wenxue, G. (State Seismological Bureau, Beijing, China). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Stable isotopic compositions of hydrogen and oxygen, together with chemical analyses were determined for 19 cold waters and 59 geothermal waters. The observed isotopic composition of waters of Beijing area and the Tanlu deep fault zone show meteoric origin and latitude-elevation dependence. The distribution of deuterium in space and depth demonstrates an increase from periphery to the center of the depression with depth, which can be explained by isotopes occurring more intensely in the rechargement area than in discharging stagnant zone. The thermal waters of E and Z aquifer complexes with higher mineralization and Cl concentration and heavier hydrogen isotopes are assumed to be representative of synergenetic connate water of the depression. The isotopic exchange between water and country rocks apparently occurred and resulted in oxygen shift of most Jizhong waters to different extent. The arguments remain open on origin of anomalously mineralized Cl-Na brines from the Jizhong depression. However, the possibility of water from lower crust and upper mantle involved in formation of the brines needs to be determined.

20303 **Geochemistry and isotopes of fluids from Sulfur Springs, Valles Caldera, New Mexico.** Goff, F.; Garnder, J.; Vidale, R.; Charles, R. (Los Alamos National Lab., NM). *Journal of Volcanology and Geothermal Research;* **23**: 273-297(1985).

The most intense activity occurs at the intersection of faults offsetting caldera-fill deposits and post-caldera rhyolites. Three geothermal well in the area have encountered pressures $<1$ MPa and temperatures of 200 C at depths of 600 to 1000 M. Non-condensible gases consist of roughly 99% $CO_2$ with minor amounts of $H_2S$, $H_2$, and $CH_4$. Empirical gas geothermometry suggests a deep reservoir temperature of 215 to 280 C. Comparison of $^{13}C$ and $^{18}O$ between $CaCO_3$ from well cuttings and $CO_2$ from fumarole steam indicates a fractionation temperature between 200 and 300 C by decarbonation of hydrothermally altered Paleozoic limestone and vein calcite in the reservoir rocks. Tritium concentrations obtained from steam condensed in a mudpot and deep reservoir fluids suggests the steam originates from a reservoir whose water is mostly $>50$ yrs old. Deuterium contents of fumarole steam, deep reservoir fluid, and local meteoric water are practically identical even though $^{18}O$ contents range through 4%, thus, precipitation on the resurgent dome of the caldera could recharge the hydrothermal system by slow percolation. From analysis of D and $^{18}O$ values between fumarol steam and deep reservoir fluid, steam reaches the surface either (1) by vaporizing the relatively shallow groundwater at 200 C or (2) by means of a two-stage boiling process through an intermediate level reservoir at roughly 200 C. Although many characteristics of known vapor-dominated geothermal systems are found at Sulphur Springs, fundamental differences exist in temperature and pressure of the postulated vapor-zone. The authors propose that the reservoir beneath Sulphur Springs is too small or too poorly confined to sustain a true vapor-dominated system and that the Sulphur Springs system may be a dying vapor-dominated system that has practically boiled itself dry. 47 references.

20304 **Gibbs free energy of mixing of natural silicate liquids; an expanded regular solution approximation for the calculation of magmatic intensive variables.** Ghiorso, M.S.; Carmichael, I.S.E.; Rivers, M.L.; Sack, R.O. (Univ. of Washington, Seattle). *Contributions to Mineralogy and Petrology;* **84**: 107-145(1983). Contract W-7405-ENG-48.

The compositions of liquids coexisting with experimentally grown crystals of olivine, plagioclase, clinopyroxene, orthopyroxene, leucite, spinel, rhombohedral oxide, melilite and potassium feldspar are used to define, through mass action expressions of liquid/solid equilibrium, compositional derivatives of the Gibbs free energy of mixing of naturally occurring silicate liquids as a function of temperature, pressure and the fugacity of oxygen. Strictly symmetric, temperature and pressure independent, regular solution interaction parameters are calibrated from phase equilibrium data using regression techniques. A mathematical procedure based upon minimization of the Gibbs free energy of mixing is developed for the calculation of the compositions of coexisting immiscible liquids. Calculations suggest that an immiscible dome, in temperature-composition space, intersects the liquidus field of the magma type tholeiite. The regular solution model is used in four petrological applications. The first concerns a prediction of the binary olivine-liquid phase diagram. The second concerns estimating the depth of the source regions of several basic lavas whose compositions cover a range from ugandite to basaltic andesite. The third application is a calculation of the saturation temperatures and compositions of plagioclase and olivine in four experimental basaltic liquids and a prediction of the liquidus temperatures and first phenocryst compositions of the Thingmuli lava series of Eastern Iceland. Lastly, enthalpies of fusion are computed for a variety of stoichiometric compounds of geologic interest. 137 references, 9 figures, 22 tables.

**20305 Heat diffusion with time-dependent convective boundary conditions.** Becker, N.M.; Bivins, R.L.; Hsu, Y.C.; Murphy, H.D.; White, A.B. Jr.; Wing, G.M. (Los Alamos National Lab., NM). *International Journal for Numerical Methods in Engineering;* **19**: 1871-1880(1983).

The heating (or cooling) of the rock adjacent to water flowing through a crevice is of interest in certain geothermal studies. For many purposes, only the rock temperature at the rock-water interface is needed. The fact that the convective heat transfer coefficient is a function of time in the case of unsteady flow takes this problem out of the strictly classical domain. Several methods of solution are described. An approach in which the heat equation is solved, under appropriate side conditions, by standard finite difference techniques is shown to be satisfactory but rather wasteful because much unneeded information concerning internal rock temperatures must be obtained. Several integral equations of Volterra type are derived that provide the temperature only at the interface. Two numerical approaches to their solution are described: one quite classical and only partially effective; the other an apparently new algorithm that is fast and efficient. Analytical upper and lower bounds on the temperature are obtained and serve to demonstrate that this numerical device is also very accurate. The algorithm is applicable to a wide class of Volterra integral equations of the second kind. A brief discussion of the possible future uses of this scheme and the need for additional research is given. 5 references, 3 figures.

# 16 TIDAL AND WAVE POWER

## 1608 Wave Energy Converters

**20306 (ETSU-WV—1570-P18) Department of Energy, Wave Energy Steering Committee, United Kingdom Wave Energy Programme: Consultants' 1983 report. Vol. 2B. Supporting information and methodology. Part E -Civil; Part F - Mechanical and electrical; Part G - Consultants' working papers; Part H - Contractors and sub-contractors in the programme.** (Rendel Palmer and Tritton, London (UK); Kennedy and Donkin, Consulting Engineers, Woking, Surrey (UK)). Jun 1983. vp. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

This comprehensive volume covers fatigue in concrete with reference to wave energy devices, design and analysis of concrete spines, design methods and bases, length of the 1982 Clam spine and breaking wave force. Mechanical and electrical aspects discussed include definition of 2GW station, power generation systems for devices using air as the conversion medium, wave energy transmission and operational reliability of H.V. submarine cables and overhead lines. Consultant's working papers with abstracts and contractors are listed.

# 17 WIND ENERGY

## 1706 Wind Energy Engineering

**20307 Vertical axis wind turbine power regulation through centrifugally pumped lift spoiling.** Klimas, P.C.; Sladky, J.F. (Sandia National Labs., Albuquerque, NM). pp 2142-2146 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper describes an approach for lowering the rated windspeeds of Darrieus-type vertical axis wind turbines (VAWTs) whose blades are hollow aluminum extrusions. The blades, which when rotating act as centrifugal pumps, are fitted with a series of small perforations distributed along a portion of the blades' span. By valving the ends of the hollow blades, flow into the blade ends and out of the perforations may be controlled. This flow can induce premature aerodynamic stall on the blade elements, thereby reducing both the rated power of the turbine and its cost-of-energy. The concept has been proven on the Sandia National Laboratories 5-m diameter research VAWT and force balance and flow visualization wind tunnel tests have been conducted using a blade section designed for the VAWT application.

**20308 Comprehensively assessing the extremely diverse renewable energy resource.** Chappell, M.; Cadogan, J. (Dept. of Energy). pp 2627-2630 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper discusses the assessment of renewable energy sources. Topics considered include wind power, wind turbines, performance, financial incentives, cost benefit analysis, fabrication, reliability, tax credits, installation, and commercialization.

# 20 ELECTRIC POWER ENGINEERING

**20309 (SAND—86-7045) Automatic generation control simulation: Program reference manual.** (Power Math Associates, Inc., Del Mar, CA (USA); Sandia National Labs., Albuquerque, NM (USA)). Mar 1987. Contract AC04-76DP00789. 125p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87006775.

This manual provides information for installing and maintaining the computer program "Automatic Generation Control Simulation," a program designed to provide a convenient mechanism for studying the time domain behavior of a power system that consists of several interconnected areas, each containing multiple generating stations. Though the manual emphasizes installation of the program on the VAX family of computers and on the IBM PC microcomputer family, the information offered is sufficiently general to assist installation on other computers as well. The manual assumes that the user is well acquainted with the computer on which the program is to operate and with the operating system of that computer. Though a tutorial on code installation or maintenance is not provided, the manual does contain all information required to understand the Automatic Generation Control Simulation program, its structure, its operation, and its modular content.

## 2001 Power Plants And Power Generation

*REFER ALSO TO CITATION(S) 19892, 19963, 19963, 19964, 19964*

**20310 (DOE/MC/22164—2188) Alkali species characterization for coal-fueled gas turbine: Final report.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Center). 31 Dec 1986. Contract AC21-85MC22164. 46p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87004789.

A key factor in the direct use of coal in gas turbines is the behavior of ash. Advanced coal cleaning processes will reduce ash levels of the order of 0.2 to 1%, which are substantially higher than for crude or residual oils. Perhaps, even of greater concern are the alkali metals, which have been directly implicated in corrosion and deposition enhancement for petroleum fuels. The objective of the program described in this report was to experimentally examine the transformation of ash, and in particular, alkali metals during combustion and deposition in gas turbine environments, and to examine the effect of these transformations on deposition rates and deposit character. It is likely that the coal cleaning method will have a major effect on the composition of the CWM ash. Thus CWM fuels prepared by physical cleaning and by chemical leaching were investigated. Ash transformation experiments yielded key information regarding the corrosive and erosive behavior of CWM fuels. Ash particles, which were in the submicron range, also are not expected to be erosive because of their small size. Thus it can be concluded that erosion for these CWM fuels that contain coal particles a few microns in diameter will be minimal as long as good fuel atomization is achieved. In summary, it has been shown that alkali behavior for coal fuels is unlike that for petroleum fuels. The presence of aluminosilicates in coal ash inhibits the formation of corrosive alkali sulfates. This also affects deposition rates by eliminating the pres-

ence of deposition "glues." Coal ash deposits, however, are hard and adherent, and are cleaned with difficulty. Because of the small size of the ash particles and the buoyancy of any carbonaceous cenospheres, erosion is not expected to be a significant issue with micronized CWM fuels. 41 refs., 29 figs., 6 tabs.

20311 **(EPRI-AP—5027-Vol.1) Analysis of the off-design performance and phased construction of integrated-gasification-combined-cycle power plants: Volume 1, Results and conclusions: Final report.** Eustis, R.H.; Erbes, M.R.; Phillips, J.N. (Stanford Univ., CA (USA). High Temperature Gasdynamics Lab.; Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 112p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920266.

A sophisticated, computer-based, steady-state simulation model has been developed and used to investigate the off-design and phased-construction performance of integrated coal-gasification combined cycle (IGCC) power plants. The ASPEN process simulator was used as the basic framework for the complete systems model; enhanced FORTRAN models were developed for critical components in the plant where the standard ASPEN models were felt to be inadequate. The effects of ambient temperature and part-load operation on a commercial-scale IGCC plant were investigated and strategies to mitigate the off-design performance penalties were examined. Increased ambient temperatures were found to considerably reduce the plant output; this effect could be mitigated through the use of supplemental firing at the expense of increasing the heat rate. Part-load performance could be considerably improved by shutting down one or more gas turbines to enable the other gas turbine trains to operate nearer to full load. The performance of various initial and final plant configurations for the phased-construction operation of IGCC power plants was examined in detail. It was found that if the plant were optimized for operation as a natural-gas-fired combined cycle plant, several critical components would be undersized when the plant was converted to IGCC operation. Similarly, some components would be oversized if the plant were designed for IGCC operation but operated as a combined cycle plant. Operating strategies and reconstruction techniques to mitigate these performance penalties were also investigated. 19 refs., 31 figs., 19 tabs.

20312 **(EPRI-AP—5027-Vol.2) Analysis of the off-design performance and phased construction of integrated-gasification-combined-cycle power plants: Volume 2, Models and procedures: Final report.** Eustis, R.H.; Erbes, M.R.; Phillips, J.N. (Stanford Univ., CA (USA). High Temperature Gasdynamics Lab.; Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 194p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920267.

A sophisticated, computer-based, steady-state simulation model has been developed and used to investigate the off-design and phased-construction performance of integrated coal-gasification combined cycle (IGCC) power plants. The ASPEN process simulator was used as the basic framework for the complete systems model; enhanced FORTRAN models were developed for critical components in the plant where the standard ASPEN models were felt to be inadequate. The effects of ambient temperature and part-load operation on a commercial-scale IGCC plant were investigated and strategies to mitigate the off-design performance penalties were examined. Increased ambient temperatures were found to considerably reduce the plant output; this effect could be mitigated through the use of supplemental firing at the expense of increasing the heat rate. Part-load performance could be considerably improved by shutting down one or more gas turbines to enable the other gas turbine trains to operate nearer to full load. The performance of various initial and final plant configurations for the phased-construction operation of IGCC power plants was examined in detail. It was found that if the plant were optimized for operation as a natural-gas-fired combined cycle plant, several critical components would be underdized when the plant was converted to IGCC operation. Similarly, some components would be oversized if the plant were designed for IGCC operation but operated as a combined cycle plant. Operating strategies and reconstruction techniques to mitigate these performance penalties were also investigated. 60 figs., 5 tabs.

20313 **(EPRI-AP—5078) Coatings technology for hot components of industrial combustion turbines: A review of the state of the art: Final report.** McMinn, A. (Southwest Research Inst., San Antonio, TX (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 92p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920269.

Choosing an appropriate corrosion-resistant coating for hot turbine components from a bewildering array of commercially available products can be a challenging task. This discussion of the fundamentals of coatings technology offers utilities helpful guidelines for selecting and evaluating turbine coatings.

20314 **(EPRI-CS—4774) Guidelines for the evaluation of seam-welded steam pipes: Final report.** Becker, F.L.; Walker, S.M.; Viswanathan, R. (Jones (J.A.) Applied Research Co., Charlotte, NC (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 194p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920279.

An inspection guideline has been developed to detect flaws, cracks, and creep damage in the weld region of longitudinally welded steam pipes. Included is a logical approach or "Road Map" to step utilities through each phase of an inspection program: how to determine if seam-welded pipes are present in a utility system; how to determine which pipes to inspect first; the types of flaws and defects that could be present; the possible inspection techniques and the optimum methodology to use; how to size any flaws that are found; how to determine the severity of the flaw and the remaining life of the pipe; and finally how to decide whether to repair, replace, or continue operating with a repetitive inspection and assessment program. 35 refs., 73 figs., 9 tabs.

20315 **(EPRI-CS—5071) Fireside corrosion and fly ash erosion in boilers: Final report.** Williams, D.N.; Hazard, H.R.; Krause, H.H.; Flanigan, L.J.; Barrett, R.E. (Battelle Columbus Div., OH (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 238p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920273.

This report presents the results of a study to assess the state of the art on current methods of reducing the importance of fireside corrosion and flyash erosion as factors responsible for tube failures in utility boilers. In the study, the causes attributed to these problems were evaluated and the remedial measures that are used in practice, and that are available and could be used were reviewed. The approach was based on discussions with personnel at ten utilities, chosen because of their experience with these problems. Fireside corrosion and flyash erosion are considered to be major problems only at those units burning coal that is rated as very aggressive (high sulfur, alkalis, and chlorine), or that contains a high percentage of erosive minerals such as quartz in the ash. These problems are being effectively managed by extensive maintenance and the use of sacrificial, temporary measures such as pad welding, and the fitting of tube shields. There are available, proven, permanent solutions for most of the fireside corrosion and flyash erosion problems encountered. These are not widely applied because the costs of installation are perceived to compare unfavorably with continued maintenance activities. Nevertheless, several forced outages annually are still caused by fireside corrosion or flyash erosion. It is important to note that these are typically repeat failures in the same location, and often the same tube, which indicates that the palliative solutions which have been applied have been ineffective. There are permanent solutions which could be worthwhile to US utilities, and there is sufficient incentive for some utilities to try them. An important example is the use of cold air velocity measurements for the selection and siting of screens and baffles, which has been shown to be capable of essentially eliminating flyash erosion as a boiler tube failure mechanism. 47 refs., 32 figs., 30 tabs.

20316 **(NP—7770075) Maintenance model for power plant components considering aspects of availability and economy power plant safety, reliability and maintenance.** Hlubek, W. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Maschinenwesen). 25 Jun 1985. 67p. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE87770075.

The publication summarizes the measures contributing to the systematic maintenance of power plants. The measures dealt with are designed to improve the plants' operational availability and economy. After discussing the importance of operational availability and economy the author points out availability optimization models and models serving to organize maintenance strategies. The discussion is followed by an analysis of the transfer of operational experiences and information. Moreover, the publication deals with the development of power plant maintenance models and refers to a number of major components exemplifying their practical application. The final chapters discuss and summarize the results obtained during the model's practical application. (HAG).

## 2002 Environmental Control Technology

*REFER ALSO TO CITATION(S) 19921, 19922, 21077, 21078, 21079, 21091, 21092*

20317 **(DOE/PC/70771—T4) Kinetics of nitrogen and sulfur reactions in combustion systems: Quarterly report No. 6.** (Energy and Environmental Research Corp., Irvine, CA (USA)). 1985. Contract AC22-84PC70771. 72p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87005647.

Four aspects of the contract, "Kinetics of Sulfur and Nitrogen Reactions in Combustion Systems" (DE-AC22-84PC70771), are summarized in this report. The four subjects covered include (1) the development of the kinetics of NO reduction on soot, (2) a discussion of the mechanisms of heterogeneous NO/sub x/ reactions in coal combustion, (3) a summary of the distributed pore model, and (4) the application of the sulfation models to the problem of enhanced reactivity at high heating rates. The overall program is designed to support one goal: develop the crucial fundamental mechanistic and quantitative rate information on the chemistry of formation and control of sulfur and nitrogen oxides as they pertain to pulverized coal fired systems. Because this area is so broad, the activity is focused somewhat on viable emerging control technologies. These technologies are specifically: NO/sub x/ control: staged combustion, reburning (fuel staging), and sorbents for NO/sub x/ capture; and SO/sub x/ control: calcium-based sorbents, low-temperature sorbents, and additives and preprocessing of calcium sorbents. However, it is expected that the fundamental mechanistic data that results from investigating issues related to the specific control technologies will have much broader long-range applications. In particular, new technologies may actually arise from the mechanistic kinetics information if they identify the major fundamental limitations to existing technologies. Two sections have been entered individually into EDB and ERA.

20318 **(EPRI-CS—5032) Performance of mechanical systems for condenser cleaning: Final report.** Aschoff, A.F.; Rosen, M.D.; Sopocy, D.M. (Sargent and Lundy, Chicago, IL (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Jan 1987. 43p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920252.

On-line mechanical condenser cleaning systems have been installed by a number of utilities to control fouling and improve cycle efficiency. Approximately 20% of all generating units in the United States larger than 100 MW currently utilize mechanical cleaning systems. There are many installations where either mechanical cleaning and/or chemical treatment could be utilized to control condenser fouling. Selection of the proper alternative(s) should be based on economics, ability to control the particular foulants in the cooling water system, and any environmental regulations that may restrict chemical usage. The purpose of this report is to provide an assessment of on-line cleaning system performance and economics. The assessment of performance is based largely on a telephone survey of 120 North American power plants with condenser cleaning systems. The economics, which were developed specifically for this study, cover both sponge ball and brush systems, in new and retrofit installations, and include comparisons with off-line cleaning and chlorination/dechlorination. In addition to the assessment of performance and economics, recommendations for future cleaning system research are provided which would benefit utilities considering installation of these systems.

## 2003 Power Transmission And Distribution

20319 **(BNL—38807) Residential hybrid power for load leveling and efficiency gains: A concept overview.** Wilhelm, W.G.; Mubayi, V.; Salzano, F. (Brookhaven National Lab., Upton, NY (USA)). Apr 1986. Contract AC02-76CH00016. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006458.

In this new concept, a local direct current (DC) power distribution system for residential consumers is proposed for its advantages to both the utility and its customers. The DC distribution is limited to the short spans emanating from the residential power terminal. Alternating current power is maintained for its transmission advantages to the load center of the residence and is there converted to low voltage direct current for distribution in the house. This approach used in combination with electronically monitored appliance-resident electrical storage constitutes the basics of a new system that promises greatly improved load management and higher operating efficiency. The objective in this concept is to make the residential customer look like a quasi-steady state power consumer with the additional option for load shedding without any disturbance in service. Even utilities with a good overall match between supply and demand can benefit from this new approach and cut operating cost by redistributing demand more evenly throughout the hours of the day. The basic object is to improve the utility load curves by smoothing out the peaks and valleys of customer demand without resorting to the complex assorted options being considered today.

20320 **(CONF-870203—2) Steep front short duration low voltage impulse performance of distribution transformers.** Burrage, L.M.; Veverka, E.F.; McConnell, B.W. (McGraw-Edison Power Systems Div., Franksville, WI (USA). Thomas A. Edison Technical Center; Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004078.

From Institute of Electrical and Electronic Engineers/ Power Engineering Society winter meeting; New Orleans, LA, USA (1 Feb 1987).

An extensive literature search of steep front short duration (SFSD) impulse sources, their characteristics and effect on power system equipment has led to the specification of a test program to evaluate key apparatus and insulations. Distribution transformers, although not overly susceptible to impulse damage, have been selected as one of the candidate apparatus for low and high voltage SFSD impulse tests. This paper covers the low voltage SFSD impulse response of conventional oil insulated shell form and core form distribution transformers.

20321 **The Athens Automation and Control Experiment Distribution Automation Project.** Purucker, S.L. (Energy Div., Oak Ridge National Lab., Oak Ridge, TN). pp 1-4 of 1986 rural electric power conference. Piscataway, NJ; IEEE Service Center (1986). (CONF-860455—). Contract AC05-84OR21400.

From Rural electric power conference; Charleston, SC, USA (20 Apr 1986).

The Athens Automation and Control Experiment is a research and development project for a distribution automation system. The purpose of the experiment is to improve the efficiency and controllability of the power system by automating the distribution system, developing test control strategies, and testing those strategies. The automation hardware described in this paper has been installed on the Athens Utilities Board distribution system in Athens, Tennessee. Experiments designed to develop and test load control, volt/var control, and system reconfiguration functions are under way. A primary objective of the distribution automation experiments is the transfer of the experimental results to the electric

utility industry. The project is sponsored by the Office of Energy Storage and Distribution, Electric Energy Systems Program, U.S. Department of Energy, and by the Electric Power Research Institute.

# 21 NUCLEAR POWER PLANTS

## 2101 Power Reactors, Non-breeding, Light-water Moderated, Boiling Water Cooled

*REFER ALSO TO CITATION(S) 20144, 20400, 20409, 20418, 20419, 20433, 20434, 20435, 20436, 20437, 20438*

20322 **(EIR—602) Calculation of the fine spectrum and integration of the resonance cross sections in the cells.** (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Oct 1986. 71p. (In French). NTIS (US Sales Only), PC A04/MF A01. File Number DE87701469.

The code BOXER is used for the neutronics calculations of two-dimensional LWR arrays. During the calculation of the group constants of the cells (pin, clad and moderator), the program SLOFIN, a BOXER module, allows taking into account the self-shielding of the resonances. The resonance range is devided into two parts: - above 907 eV the cross sections are condensed into groups by the library code ETOBOX. In SLOFIN, these values are interpolated over the equivalent cross section and the temperature. The interpolation formula chosen gives an accuracy better than 1% for values of the equivalent cross section larger than 5 barns. - between 4 and 907 eV, the cross sections are given in pointwise form as a function of the lethargy. At first a list of pointwise macroscopic cross section is established. Then the fine spectrum in the cell is calculated in 2 or 3 zones by means of the collision probability theory. In the central zone one resonant pseudo-nuclide is considered for the calculation of the scattering source, while the light nuclides are explicitly treated but under the assumption of energy independent cross sections. The fine spectrum is then used as a weihting function for the condensation of the pointwise cross sections of the resonant nuclides into energy groups. The procedure was checked on the basis of the TRX-1 to -4 and BAPL-UO/sub 2/-1 to -3 experiments which are used as benchmarks for the tests of the ENDF/B libraries. The comparisons with other calculation results show that the deviations observed are typical for the basic cross sections. The method proposed shows a good accuracy in the application range foreseen for BOXER. It is also fast enough to be used as a standard method in a cell code.

20323 **(EIR—603) Validation of the EIR LWR calculation methods for criticality assessment of storage pools.** (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Nov 1986. 28p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87701470.

The EIR code system for the calculation of light water reactors is presented and the methods used are briefly described. The application of the system to various types of critical experiments and benchmark problems proves its good accuracy, even for heterogeneous configurations containing strong neutron absorbers such as Boral. Since the multiplication factor k/sub eff/ is normally somewhat overpredicted and the spread of the results is small, this code system is validated for the calculation of storage pools, taking into account a safety margins of 1.5% on k/sub eff/.

20324 **(EUR—10118) Qualification, training, licensing and retraining of operating shift personnel in nuclear power plants. Presentation of different procedures in the countries of the European Community, Spain, Sweden, Switzerland and the USA.** Pfeffer, W.; Kraut, A. (Commission of the European Communities, Luxembourg). 1985. 429p. NTIS (US Sales Only), PC A19/MF A01. File Number DE87751013.

This study aims at evaluating and compiling the procedures to reach the necessary qualification applied in the countries of the European Community, Sweden, Spain, Switzerland and the United States of America. Additionally to the presentation of practice the report is to show similarities - as far as they were identified - and special topics or aspects worth mentioning. In the report the following topics are dealt with: tasks of the shift personnel, nomenclature for different groups of personnel; shift staffing of the control room; criteria for personnel selection when new shift staff; personnel qualification necessary for recruitment; training of shift personnel; retraining for preservation of the qualification standard; training facilities, especially simulators; licensing or authorization of shift personnel; training and education organization. The study is based on the evaluation of EC documents as well as well as general publications and reports. To check the results and to integrate some lacking information the report was discussed in a meeting of an ad hoc subgroup of the CEC working group dealing with the safety of light-water reactors, joined by specialists from Spain, Sweden and Switzerland. 121 refs.

## 2102 Power Reactors, Non-breeding, Light-water Moderated, Non-boiling Water Cooled

*REFER ALSO TO CITATION(S) 20144, 20322, 20323, 20324, 20395, 20397, 20400, 20409, 20411, 20412, 20413, 20414, 20418, 20420, 20421, 20426, 20427, 20428, 20430, 20431, 20432, 20433, 20434, 20435, 20436, 20437, 20438, 20442, 20443, 20445*

20325 **(CEA-CONF—8495) Consequences of the increase of burnup on the fuel.** Melin, P.; Lavoine, O.; Houdaille, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Apr 1986. 18p. (In French). (CONF-8604283—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750982.

From SFEN technical meeting; Cadarache, France (11 Apr 1986).

The examinations carried out on the FRAGEMA fuel of EDF reactors show its good behavior in service. The results of research and development programs developed by EDF, FGA and the CEA show that this fuel can be irradiated up to a high burnup, and allow to point out the axies of research to improve still the performance of the product in a more and more soliciting environment (increase of power and burnup coupled with load following). Among the solutions considered, there are the design and fabrication adjustments (geometry, initial pressurization), more fundamental changes concerning fuel cans and fuel pellets, which need still research and development programs.

20326 **(CEA-CONF—8569) Intergranular attack of alloy 600 in PWR steam generator tubes simulation tests.** Daret, J.; Santarini, G. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Mar 1986. 11p. (CONF-860304—10). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751020.

From Corrosion '86; Houston, TX, USA (17 Mar 1986).

In some steam generators, intergranular attack (IGA) has been detected on alloy 600 tubes within or near the tubesheet crevice region. A work was undertaken to reproduce IGA in an experimental device simulating actual steam generators conditions. A special tubesheet assembly was designed with representative materials and geometry. Thermal-hydraulic conditions of the hot leg side of the generators and sludge piles were simulated. During three runs of four tests each, chemical parameters and test procedures were adjusted to finally obtain a high concentration of alkalies in the tubesheet crevices and a representative corrosion attack of tubing materials. In the two first runs, stress corrosion cracking (SCC) in the tubing cut short the tests, and IGA was minor. In the third run chemicals were initially forced into the crevices so that SCC was delayed and IGA favoured. Mill-annealed (MA) alloy 600 was the most susceptible to IGA. A thermal treatment (TT) at 700°C given to that material decreased the amount of IGA. The least vulnerable material was an experimental alloy 690.

20327 **(CEA-DAS—222) French regulatory practice and reflections on the leak-before-break concept.** Barrachin, B.; Bouche, D.; Jamet, P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). 1986. 21p. (In French and English). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751028.

For nuclear units in the design phase, the vendor (Framatome) and the utility (EDF) examine the possibility of applying the leak-before-break criterion to a certain number of circuits, particularly the primary circuit and various parts of the secondary circuit. EDF has not completed its reflection on the leak-before-break approach and consequently, French safety authorities have not been officially notified of any request for assessment of the acceptability of such an approach. Nevertheless, from a strict safety point of view, it is possible to determine minimal conditions required in the implementation of such a course of action. Firstly, removing pipe breaks from the design basis of the plant will significantly weaken the application of the defense in-depth concept. This must be counter-balanced by reinforced manufacturing non destructive examinations and a stringent in-service inspection. Secondly, the demonstration of the existence of leaks before breaks must be obtained with a high degree of certainty, which requires large investments in a certain number of fields. The exact methodology will be defined by the Vendor and the utility at a later stage. However, from our point of view, analysis should involve the following steps: Definition of a maximum size defect; analysis of evolution under normal loads; stability analysis, definition of the critical defect; Definition of the detectable defect. This paper develops each of these points, and specifies, for each discipline, the domains in which present knowledge must be expanded and deepened.

20328 **(CNEN-DR-GTT—01/84) First step of the project for implementation of two non-symmetric cooling loops modeled by the ALMOD3 code.** (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro. Dept. de Reatores). Sep 1984. 114p. (In Portuguese). NTIS (US Sales Only), PC A06/MF A01. File Number DE87700849.

The first step of the project for implementation of two non-symmetric cooling loops modeled by the ALMOD3 computer code is presented. This step consists of the introduction of a simplified model for simulating the steam generator. This model is the GEVAP computer code, integrant part of LOOP code, which simulates the primary coolant circuit of PWR nuclear power plants during transients. The ALMOD3 computer code has a model for the steam generator, called UTSG, which is very detailed. This model has spatial dependence, correlations for 2-phase flow, distinguished correlations for different heat transfer process. The GEVAP model has thermal equilibrium between phases (gaseous and liquid homogeneous mixture), no spatial dependence and uses only one generalized correlation to treat several heat transfer processes.

20329 **(CNEN-DR-GTT—01/86) Adjustments in the ALMOD 3W2 code models for reproducing the net load trip test in Angra I Nuclear Power Plant.** (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro). Sep 1986. 22p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700850.

The recorded traces got from the net load trip test in Angra I NPP yelded the opportunity to make fine adjustments in the ALMOD 3W2 code models. The changes are described and the results are compared against plant real data.

20330 **(CNEN-DR-GTT—02/85) Second and third stages of project for the implementation of two asymmetric cooling loops modeled by the ALMOD3 code.** (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro. Dept. de Reatores). Apr 1985. 181p. (In Portuguese). NTIS (US Sales Only), PC A09/MF A01. File Number DE87700851.

The second and third steps of the project for implementation of two non-symmetric cooling loops modeled by the ALMOD3 computer code are presented. These steps consists in activate the option for 2 loops already present in ALMOD3 original version and to introduce the GEVAP model for one of the two steam generators. In ALMOD3 original version the simulation of two non-symmetric loops was only possible using external functions, which provide the removed heat for each time step for one of the steam generators. With the introduction of GEVAP model, it is possible to obtain more accurate results. Due to its simplicity, the computer time required for execution is short. The results obtained in Angra 1 simulations are presented, analysed and compared with results obtained using one loop for simulating symmetric transients.

20331 **(EIR—605) Core optimization studies for a small heating reactor.** (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Nov 1986. 42p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87701476.

Small heating reactor cores are characterized by a high contribution of the leakage to the neutron balance and by a large power density variation in the axial direction. A limited number of positions is available for the control rods, which are necessary to satisfy overall reactivity requirements subject to a safety related constraint on the maximum worth of each rod. Design approaches aimed to improve safety and fuel utilization performance of the core include separation of the cooling and moderating functions of the water with the core in order to reduce hot-to-cold reactivity shift and judicious application of the axial Gd zoning aimed to improve the discharge burnup distribution. Several design options are analyzed indicating a satisfactory solution of the axial burnup distribution problem. The feasibility of the control rod system including zircaloy, stainless steel, natural boron and possibly enriched boron rods is demonstrated. A preliminary analysis indicates directions for further improvements of the core performance by an additional reduction of the hot-to-cold reactivity shift and by a reduction of the depletion reactivity swing adopting a higher gadolinium concentration in the fuel or a two-batch fuel management scheme.

20332 **(EPRI-NP—5026) Assessment of sulfur in chemical cleaning of PWR [pressurized water reactor] steam generators: Final report.** Jevec, J.M.; Leedy, W.S.; Barna, J.L. (Babcock and Wilcox Co., Alliance, OH (USA). Research and Development Div.; Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 267p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920304.

Chemical cleaning, designed to remove corrosion products from PWR steam generators where mechanical cleaning is inadequate or impossible, leaves sulfur-bearing residues on alloy 600 tubing. This project investigated the potential side effects of these residues and showed that they do not increase the susceptibility of tubes to attack.

20333 **(FRADOC—7-7) Mechanical behaviour of the reactor vessel support of a pressurized water reactor: tests and analysis.** Bolvin, M.; L'huby, Y.; Quillico, J.J.; Humbert, J.M.; Thomas, J.P.; Hugenschmitt, R. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Aug 1985. 7p. (CONF-850809—86). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750992.

From 8. international conference on structural mechanics in reactor technology; Brussels, Belgium (19 Aug 1985).

The PWR reactor vessel is supported by a steel ring laying on the reactor pit. This support has to ensure a good behaviour of the vessel in the event of accidental conditions (earthquake and pipe rupture). A new evolution of the evaluation methods of the applied forces has shown a significant increase in the design loads used until now. In order to take into account these new forces, we carried out a test on a representative mock-up of the vessel support (scale 1/6). This test was performed by CEA, EDF and FRAMATOME. Several static equivalent forces were applied on the experimental mock-up. Displacements and strains were simultaneously recorded. The results of the test have enabled to justify the design of the pit and the ring, to show up a wide safety margin until the collapse of the structures and to check our hypothesis about the transmission of the forces between the ring and the pit.

20334 **(FRADOC—8-4) Steam generators improvement of separator dryer performance. Design and test program.** Holcblat, A. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Oct 1985. 26p. (CONF-851022—3). NTIS (US Sales Only), PC A03/MF A01. File Number DE87750994.

From BNES conference on boiler dynamics and control in nuclear power stations; Yorkshire, UK (21 Oct 1985).

The first generation of steam generators built in France (model 51) experienced some moisture problems. As early as 1976,

a large-scale development program was undertaken by Framatome, in collaboration with the French Commissariat a l'Energie Atomique and Electricite de France, to enhance design of SG separation equipment. The goal of this program was to enhance equipment operating efficiency by improving our understanding of separation phenomena. This paper presents an overview of the design and testing effort engaged within the framework of the separator development program, along with a summary of program results and forthcoming developments.

20335 **(FRADOC—8-5) Recent progress in SG level control in French PWR plants.** Parry, A.; Petetrot, J.F.; Vivier, M.J. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Oct 1985. 9p. (CONF-851022—4). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750995.

From BNES conference on boiler dynamics and control in nuclear power stations; Yorkshire, UK (21 Oct 1985).

Controlling the steam generator (SG) level is of major importance in a large PWR plant. This has led to extensive work on SG computer models. This paper presents results of the comparison between calculations and tests on the first four-loop plant in France. Four-loop plants started up after 1985 will be equipped with digital instead of analog controllers. A new SG level control has been designed and then optimised using the validated SG model. A prototype of this new system has been successfully tested on a three-loop plant. 4 refs.

20336 **(FRADOC—8-6) Commissioning of steam generators.** Remond, A. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Dec 1985. 28p. (In French). (CONF-8512108—1). NTIS (US Sales Only), PC A03/MF A01. File Number DE87750996.

From Meeting on experience of starting 1300 MW PWR; Paris, France (11 Dec 1985).

French units (4 loops-1300 MWe) use a boiler type apparatus named 68/19 (as 6800 $m^2$, tube diameter: 19) studied by Framatome from 1977 to 1979. The design study uses classical tools already developed for the theoretical analysis of steam generators of the three-loop units, but in higher-performance zones (72 bars instead of 58 bars) but at a more important power level. An experimental test on an apparatus of the new series (S.G. no 4, Paluel-1) has been juged useful. The first results are presented in this paper.

20337 **(FRADOC—8-7) Fatigue analysis of PWR steam generator tube sheet.** Billon, F.; Buchalet, C.; Podroux, G. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Jun 1985. 22p. (CONF-850648—3). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750997.

From Symposium on fluid/structure interaction; New Orleans, LA, USA (23 Jun 1985).

Usually, to determine the stresses in a T.S, a simplified axisymmetric and homogeneous model is used. This model provides nominal stresses which are then linearized and multiplied by "concentration factors" to obtain the actual stresses in the ligaments. When performing a T-S fatigue analysis, only the stresses on the secondary side surface are considered since they are maximum at that location and the usage factors are calculated using the "concentrated" linearized stresses plus the peak stresses. The French Safety Authorities (BCCN) and Utility (EDF) requested that all the surface stresses be multiplied by the "concentration factors". The severity of such an approach is much greater since high peak stresses exist on the secondary side surface of the T-S during normal operation including hot stand-by. The primary fluid circulating in the tubes maintain almost all of the T-S at the primary temperature and the primary/secondary temperature gradient is localized in a very thin layer of the T-S on the secondary side. Thus, a very precise determination of the T-S secondary side surface thermal loading and surface stresses is necessary in order to demonstrated an acceptable fatigue behaviour of this structure. The 68/19 FRAMATOME Standard 1300 MWe S.G. model is considered. The T-S fatigue analysis includes the five following steps: the determination of the S.G. design transients, of the related S.G thermohydraulic parameters, of the thermal loads on the T-S; the stress calculations in the perforated region of the T-S; and, the fatigue analysis of the T-S.

20338 **(FRADOC—8-9) Development of a method of detection of the contacts and measurement of the proximities in the PWR steam generator tubes bundles.** Morandiere, J.C. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Feb 1985. 5p. (CONF-850112—12). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750999.

From 7. international conference on nondestructive evaluation in the nuclear industry; Grenoble, France (29 Jan 1985).

An eddy current examination method for the examination of the spacing between PWR steam generator tubes was developed. It allows the detection, localization and measurement of that spacing value provided it does not exceed 4 mm.

20339 **(FRADOC—9-1) Framatome nuclear services.** Delorme, H.; Buttin, J. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). May 1985. 8p. (CONF-8504284—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751000.

From Conference on nuclear services strategies; Washington, DC, USA (28 Apr 1985).

Framatome is a French company whose main activities since 1958 have been the design and manufacture of standardized PWR Nuclear Steam Supply Systems. Framatome builds the Reactor Coolant System components and installs and starts-up the extended Nuclear Steam Supply Systems. In addition to the supply of spare parts of tooling, the services offered by Framatome are implementation of backfits aimed at performance and safety improvement and equipment reliability, technical assistance and, maintenance and repair services.

20340 **(FRADOC—9-2) Nuclear engineering and manufacturing technology transfer coproduction with technical assistance.** Marillier, J.C.; Boury, C. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Oct 1985. 12p. (CONF-851037—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751001.

From 3. international conference on nuclear technology transfer; Madrid, Spain (14 Oct 1985).

This paper emphasizes in the specific areas of design, engineering, and component production. This paper presents what Framatome has to offer in these areas and its export oriented philosophy. Then, a typical example of successful implementation of this technology transfer philosophy is the collaboration with the South Korean firm, Korea Heavy Industries Corporation (KHIC) for the supply of KNU 9 and KNU 10 power stations.

20341 **(FRADOC—9-3) Transfer of technology in maintenance tools.** Delorme, H.; Cartry, J.P. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Oct 1985. 10p. (CONF-851037—2). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751002.

From 3. international conference on nuclear technology transfer; Madrid, Spain (14 Oct 1985).

For maximum reliability of maintenance operations, Framatome has aimed to improve the accessibility of highly irradiated and contaminated reactor coolant system equipment by the active promotion of an automation and robotization strategy. A number of robot designs have been developed providing replacement of operators inside the steam generator channel head, smooth handling of heavy or cumbersome objects in this zone, easy marking of steam generator tubes and increased speed of repetitive channel head operations: maintenance spider, theta-theta prime robotic service arm, R-theta robotic service arm, remote manipulator arm. Two operations are described: channel head folding cover plate and, operation of the torquing machine for head cover plate.

20342 **(FRADOC—9-4) Implementation of quality assurance in the nuclear industry of Republic of Korea.** Voin, V. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Oct 1985. 8p. (CONF-851037—3). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751003.

From 3. international conference on nuclear technology transfer; Madrid, Spain (14 Oct 1985).

This paper describes the assistance supplied by FRAMEX to achieve establishment and implementation of Quality Assurance Program by Korean Manufacturers. But to assure that equipment purchased in Korea complies with the procurement documents, technical assistance has been provided to transfer proven, reliable know-how and technology. At this stage of the project, we can say that the total support which is available for the Korean manufacturers is efficient. We have the adequate confidence that the quality of the equipment conforms to predetermined requirements and that it will perform satisfactorily in service. Experienced and qualified personnel in Quality Assurance is now available in Korea for the development of Korean nuclear program.

20343 **(FRADOC—9-8) Use of shot-peening to improve stress corrosion resistance of steam generator tubes of PWR nuclear power plants.** Michaut, B.; Slama, G. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Nov 1985. 11p. (In French). (CONF-8511252—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751027.

From Conference on prestressing by shot peening; Senlis, France (27 Nov 1985).

A shot-peening process has been developed for treating the internal side of thin tubes (1 to 1.3 mm) of which diameter is between 19 and 22 mm, used in steam generators of nuclear power plants; this process can be applied to irradiated media. Shot-peening effect has been characterised by stress profiles in depth (internal skin; measurement by X rays) and by induced stress profiles (external skin; stress gauge). The efficiency of the process (100%) has been established by corrosion testing on mockups, either in boiling $MgCl_2$, or in caustic medium (10%) at 350°C under 180 bars of internal pressure. The process has been used with success on more than 20000 tubes and will be applied later at a larger scale in France and in foreign countries.

20344 **(FRADOC—9-9) Shot peening of French plants.** Slama, G.; Sort, M. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Dec 1985. 20p. (CONF-8512110—2). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751026.

From Workshop on primary side SCC remedial action NDE methods; Leningrad, Ukrainian SSR (10 Dec 1985).

Framatome Shot-peening process was developed when it appeared that PWSCC of M.A. Inconel 600 in roll transition areas could be an important source of tubing degradation. To be sure to have a qualified process as soon as possible Framatome and EdF set up a task force which had to consider all the remedial measures against PWSCC available in the short or the long term. Framatome concentrated on Shot-peening. This paper presents the work on shot-peening. The tests performed included corrosion tests in media such as $MgCl_2$, 10% Caustic at high temperature and direct stress measurements such as X rays and strain gauges techniques. This presentation concentrates on the effort which was devoted to establish the effect of shot-peening on precracked tubes and the amount of margins for this process. After the results of all the tests demonstrated the efficiency of this process, shot-peening was applied in France first on a small scale, 300 tubes in BUGEY 5 in August and then on the 3 Steam Generators of GRAVELINES 3 and DAMPIERRE 3 in September, October and November of 1985. The experience gained from these industrial operations (and of the tooling, process and personnel training. This resulted in a very significant decrease of time of operation, dose and bead consumption. These features are detailed in this paper and the French program scheduled in 1986 is presented. 2 refs.

20345 **(FRADOC—9-10) Shot peening of DOEL 3 plant.** Slama, G.; Sort, M. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Dec 1985. 30p. (CONF-8512110—1). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751025.

From Workshop on primary side SCC remedial action NDE methods; Leningrad, Ukrainian SSR (10 Dec 1985).

The process implementation for DOEL consisted in: developing tooling and test procedures for an industrial application including ALARA considerations; qualifying process, tooling and procedures using representative conditions (full size mock-up, of steam generator channel head and associated working area); Establishing the reliability of tooling and procedures to comply permanently with the required criteria (chiefly Almen Intensity); and training and qualifying personnel. A variety of tests were performed by FRAMATOME and BELGATOM to qualify the process and characterize its effects on both inside and outside diameters of the tubes. These are: Mg $Cl_2$; 10% caustic tests at high temperature and pressure; tetrathionate; strain gauges and X rays stresses measurements; effects on precracked tubes; Leak tests after shot peening. The operation was performed at Doel in July 1985. Laboratory tests performed on mockups by FRAMATOME and BELGATOM could demonstrate that on tubes without cracks no difference was found between Eddy current signals from tubes shot-peened or not.

20346 (IA—1421, pp 24-26) **Improved pressurizer model for DSNP.** Saphier, D. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20347 (IA—1421, pp 26-27) **General-purpose lumped-parameter steam-generator model.** Saphier, D.; Gal, D. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20348 (IA—1421, pp 27-28) **Improved water steam property functions for DSNP.** Saphier, D.; Guo, Z. (Israel Atomic Energy Commission, Tel Aviv; Georgia Inst. of Tech., Atlanta, USA). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20349 (IA—1421, pp 19-21) **Loss of offsite power analysis with DSNP.** Saphier, D. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20350 (INIS-mf—10570, pp 85-96) **Possible application of hydro power in water management system for Eastern Slovakia nuclear power plant.** Kralik, L. 1985. (In Slovak). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701462. (CONF-8505340—Exc.).

From Prediction of environmental impact of power generation conference; Bratislava, Czechoslovakia (23 May 1985).

The water management project is presented of deliveries of utility water for the planned 4 x 1000 MW nuclear power plant in the Kecerovce locality in eastern Slovakia. The designed water management system will consist of the following water projects: the Drienov dam on the Torysa, the Ruzin dam on the Hornad, the Kysak dam on the Hornad, the water transfer from the Hornad river to the Torysa, the Plavec dam on the Poprad and the transfer of water from the Poprad river to the Torysa, and the Obisovce dam on the Svinka. The technical design is described of the power use of the said projects. A total of 7 hydroelectric plants will be built with an installed power of 67.4 MW generating annually 89.6 GWh of electric power on the average. (E.S.).

20351 **(INIS-mf—10571) Scientific conference proceedings. Session 1. Nuclear power engineering.** Bartosek, V. (ed.). (Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia)). 1985. 132p. (In Czech). (CONF-8506335—Pt.1). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477.

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The scientific conference was held in Rez near Prague on June 6-7, 1985 on the occasion of the 30th anniversary of the establishment of the UJV. In session 1 - Nuclear Power Engineering - the participants heard 12 papers all of which were incorporated in INIS. They dealt with the thermohydraulic analysis of the PWR core, the reliability analysis of safety systems of WWER nuclear power plants, with in-core measurements, optimization calculations of fast reactors, thermohydraulic calculations of fast reactor fuel assemblies, emergency core cooling of fast reactors, etc. (E.S.).

20352 (INIS-mf—10571, pp 17-26) **Table of operating mode limits for V-1 nuclear power plant.** Pernica, R.; Kyncl, M.; Ferjencik, M. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477. (CONF-8506335—Pt.1).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

An analysis was made of permissible values of the V-1 nuclear power plant reactor output for different numbers of operating main circulating pumps. A reliability analysis and thermal-hydraulic verification were made of permissible reactor outputs for different operating modes, and safety criteria are given for permissibility of processes caused by the outage of main circulating pumps. The results are summarized in a table of operating mode limits. The table is compared with the table of mode limits for unit 3 of the Voronezh nuclear power plant and the project and operating table for the V-1 nuclear power plant. (E.S.).

20353 (INIS-mf—10571, pp 59-66) **First experience with operation of RVS-3 reactor water loop.** Masarik, V.; Vsolak, R.; Kysela, J. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477. (CONF-8506335—Pt.1).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The RVS-3 loop was built at UJV in Rez near Prague in the years 1977-1983 of stainless steel, the working medium is chemically treated demineralized water. The loop consists of a closed pressurized water circuit with forced circulation. A brief description is given of the different parts of the loop which was put into trial non-active operation in 1983. The basic characteristics and possibilities of control were identified and calculated parameters verified in 1984. The experimental programme for the years 1984 to 1990 is described. (E.S.).

20354 (INIS-mf—10572, pp 5-10) **Materials problems at increased fuel burnup in WWER reactors.** Kaderabek, E.; Novak, J.; Cech, B. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701473. (CONF-8506335—Pt.2).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The major processes taking place in fuel are characterized, namely the change in the dimensions of the fuel element, the release of fission gases, the hydration of the cladding and surface corrosion and the fuel-cladding interaction. The properties are summed up of the cladding material of WWER reactor fuel elements with regard to the leakage of the fuel element at increased burnup, this namely the texture of Zr1Nb tubes as compared with the texture of Zircaloy-4 tubes, Zr1Nb tube creep under axial tensile stress, corrosion cracking of tubes, the development of mechanical equations of state for Zr1Nb, the quantitative analysis of the detection of plastic deformation, and mathematical models of the mechanical pellet-cladding interaction. (E.S.).

20355 (INIS-mf—10572, pp 11-12) **Post-irradiation evaluation of components of WWER diagnostic assemblies.** Truchly, J. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701473. (CONF-8506335—Pt.2).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

A survey is given of the work performed by the staff of the nuclear materials department in the field of post-irradiation evaluation of components of diagnostic assemblies for WWER's. This work is carried out within CMEA cooperation programmes and is to contribute to increasing the reliability and safety of WWER reactors.

20356 **(KFKI—1986-56/G-J) Recent bibliography on analytical and sampling problems of a PWR primary coolant Suppl. 4.** (Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics). Sep 1986. 25p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701472.

The 4th supplement of a bibliographical series comprising the analytical and sampling problems of the primary coolant of PWR type reactors covers the literature from 1985 up to July 1986 (220 items). References are listed according to the following topics: boric acid; chloride, chlorine; general; hydrogen isotopes; iodine; iodide; noble gases; oxygen; other elements; radiation monitoring; reactor safety; sampling; water chemistry. (V.N.).

## 2103 Power Reactors, Non-breeding, Graphite Moderated

*REFER ALSO TO CITATION(S) 20415, 20425, 20429, 20438*

20357 **(ITEF—79(1985)) BISAR code for two-dimensional analysis of reactor stability relatively to slow movements of the neutron field.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 41p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87700972.

A code for calculation of thermal neutron reactor stability relative to slow movements of the neutron field conditioned by the change of sup(135)I and sup(135)Xe concentrations as well as by the change of the moderator (graphite) temperature is described. A two-dimensinal one-group diffusion equation is used to describe a spatial distribution of neutron flux. The problem is solved by the finite-difference method. 19 refs.; 5 figs.; 8 tabs.

20358 **(Juel—2070) Thermal hydraulics of disk and doughnut type heat exchangers at the example of the EVAII-steam reformer.** Groehn, H.G. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente). Jun 1986. 83p. (In German). NTIS (US Sales Only), PC A05/MF A01. File Number DE87751288.

The geometrical effects on heat transfer and pressure drop of a disk and doughnut type heat exchanger have been investigated. Additionally a cross flow tube bundle having the same tube pitches as the steam reformer has been tested for comparison. Data collected include the mean heat transfer coefficient in the Reynolds number range 10/sup 4/≦ Re ≦ 2 x 10/sup 5/ for different tube positions within the bundles, the local circumferential and spanwise heat transfer as well and the hydraulic resistance of the heat exchangers.

**20359 (Juel-Spez—347) Design criteria for metallic and ceramic high temperature reactor system components and for the prestressed concrete pressure vessel of future high temperature nuclear power plants. Status report.** (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Feb 1986. 151p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87751271.

A brief outline of design concepts of future HTR systems, - HTR-500, HTR modular system for electricity generation and process heat, HTR-100 - is followed by a discussion of the significance of various barriers for fission product retention. The general design features of HTR systems contributing to inherent safety are described. On the basis of the above facts and data, framework safety requirements are determined in part A, whereas part B concentrates on safety design criteria for metallic reactor system components, part C for components of the prestressed concrete reactor pressure vessel, and part D for graphite reactor internals. Design criteria for the components of the primary circuit envelope with temperature and time-dependent materials properties are discussed, as well as design criteria for the prestressed loadbearing part of the pressure vessel, the liner, the vessel closures and the thermal insulating systems, and the graphite reactor internals other than fuel elements. The study is intended to define criteria for structural components of HTR systems on the basis of available experience and research results, which may serve as a useful documentation of criteria for the formulation of a regulatory guide for HTR systems.

## 2105 Power Reactors, Breeding

*REFER ALSO TO CITATION(S) 20351, 20417, 20438, 20446, 20896, 21704*

**20360 (CEA-CONF—8502) Mechanical properties of the CABRI cladding (CW 316) during thermal transients.** Cauvin, R.; Allegraud, G.; Balourdet, M. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). May 1986. 7p. (CONF-860501—18). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751024.

From Conference on the science and technology of fast reactor safety; Channel Islands, UK (12 May 1986).

Mechanical properties during thermal transients were measured on unirradiated and slightly irradiated CABRI cladding (CW 316). The thermal transients simulated LOF and TOP of the CABRI safety program. It was found that controlling parameters were the heating rate, the test temperature and the strain rate, for the unirradiated material. Irradiation strongly reduced ductility, mechanical properties then depending also on irradiation temperature and fluence.

**20361 (CONF-870468—1) An examination of maintenance activities in liquid metal reactor facilities: An analysis by the Centralized Reliability Data Organization (CREDO).** Haire, M.J.; Knee, H.E.; Manning, J.J.; Manneschmidt, J.F.; Setoguchi, K. (Oak Ridge National Lab., TN (USA); Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center). 1987. Contract AC05-84OR21400. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004613.

From Reliability '87; Birmingham, UK (14 Apr 1987).

The Centralized Reliability Data Organization (CREDO) is the largest repository of liquid metal reactor (LMR) component reliability data in the world. It is jointly sponsored by the US Department of Energy (DOE) and the Power Reactor and Nuclear fuel Development Corporation (PNC) of Japan. The CREDO database contains information on a population of more than 21,000 components and approximately 1300 event records. Total experience is approaching 1.2 billion component operating hours. Although data gathering for CREDO concentrates on event (failure) information, the work reported here focuses on the maintenance information contained in CREDO and the development of maintenance critical items lists. That is, components are ranked in prioritized lists from worse to best performers from a maintenance standpoint.

**20362 (EUR—9876) Ratchetting in the creep range.** Ponter, A.R.S.; Cocks, A.C.F.; Clement, G.; Roche, R.; Corradi, L.; Franchi, A. (Commission of the European Communities, Luxembourg). 1985. 332p. NTIS (US Sales Only), PC A15/MF A01. File Number DE87751014.

This report attempts to present a "State of the Art" of this problem from three contracting and complementary points of view which reflect separate traditions within the discipline of structural analysis. Part I gives a brief summary of the essential elements of the three constitutive parts and a set of conclusions and recommendations are then formulated. Part II is an attempt by a group at CEA Saclay, France, to distil from available experimental data a set of rules expressed in terms of the stress classifications of the ASME codes, which will ensure the prevention of excessive creep ratchetting. The resulting stresses to an effective (or reference) stress and the creep assessment is then made in terms of the creep produced by the effective stress. They aim at analytical procedures for LMFBR components that operate in the creep region and are subject to considerable thermal transients. Part III by Ponter and Cocks of the University of Leicester is a theoretical study of the problem using bounding and other approximate techniques. The problem is studied in a sequence of increasingly complex problems commencing with an isothermal structure subjected to constant load and terminating in a structure subjected to arbitrary cyclic thermal loading. The results are expressed in terms of a reference stress derived from a plastic shakedown solution, and a reference history of temperature. These techniques are capable of providing assessment of the creep deformation of a structure when the plastic shakedown properties of the structures are known. The particular circumstances which occur in a LMFBR are emphasized. Part IV by Corradi and Franchi discusses the methods by which finite element solution may be calculated. These are surveyed with particular reference to the numerical problems involved and the relationship between computational procedure and the form of the constitutive equation. 162 refs.

**20363 (FEI—1672) Lumped parameter method in problems on temperature field in deformed fuel bundles of fast reactors with diabatic boundary conditions.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1985. 23p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700869.

Mathematical model for the calculation of velocity and temperature fields in deformed fuel bundles of fast reactors is described; the brief description of the program and test calculation is presented. Thermohydraulic analysis is based on the solution of the equation system of mass, momentum and energy balance for characteristic cells. The fuel bundle region is divided into above characteristics cells. Maximum values of temperature of fuel element cans and variations of temperature about the fuel element perimeter are estimated. Test calculation made for the Phenix reactor has shown a considerable increase of variations of temperature about the perimeter of fuel elements in deformed fuel bundle in comparison with a reference one. 31 refs.; 5 figs.; 1 tab.

**20364 (FEI—1693) On applying the variational method to diffusion accompanied by chemical reactions.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1985. 25p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700870.

Further development of the variational method application to the diffusion with chemical reactions is given. It is shown that the differential equation for diffusion with chemical reactions differing from the known one proceeds from the Euler Lagrange equation. A simple model of the chemical reaction is considered, on the basis of this model calculated is the burn-out of the component of the two-component liquid-metal coolant. Several consequences proceeding from the application of the variational method to the mass transfer process that is accompanied by chemical reactions are discussed. 11 refs.

20365 (INIS-mf—10571, pp 77-83) **Technical, physics and optimization calculations of fast breeder reactor and its fuel cycle.** Kujal, J.; Kujal, B.; Jakab, J. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477. (CONF-8506335—Pt.1).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The methods and computer programs are briefly described for neutron and complex computations of the fast reactor and fuel cycle and for automated optimization of the reactor. Technical designs are presented of cores of fast power reactors with heterogeneous core, of carbide fuel fast reactors and of a BN-600 type reactor with plutonium.

20366 (INIS-mf—10571, pp 85-91) **Calculations of fast reactor emergency core cooling.** Macek, J. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477. (CONF-8506335—Pt.1).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The problems are described related to transient processes in nuclear power plants during transition to natural circulation emergency cooling. Partial models were constructed of the basic components: of the reactor, the main circulation loops including pumps, intermediate exchangers, pipes and pumps of the second circuit, the steam generator. These models served for the development of computer programs which were tested by a number of variant calculations. The model of the intermedite exchanger was compared with published results. The steam generator model was tested experimentally.

20367 (INIS-mf—10571, pp 93-105) **Thermal-hydraulic calculations of fast reactor fuel assemblies.** Schmid, J.; Stach, V.; Muehlbauer, P. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477. (CONF-8506335—Pt.1).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

Calculations of hydrodynamic and temperature conditions in fuel assemblies of fast reactors are a traditional research field of UJV Rez. The results are summed up achieved over the past five years in the development of techniques and calculations of the microstructure of flow and temperature fields in laminar and turbulent coolant flow including the effects of secondary flow. The finite element method was used as the basic means for solving systems of differential equations.

20368 (INIS-mf—10571, pp 107-120) **Research of hydrodynamics of fast reactor fuel assemblies using aerodynamic models.** Hejna, J.; Cervenka, J.; Vosahlo, L.; Mantlik, F. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477. (CONF-8506335—Pt.1).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The results are summed up of a study of local hydrodynamic characteristics in the peripheral area of a BN-600 type fuel assembly, obtained on an air model since 1980. The major results are presented of measuring time centred characteristics (tangential stress on wetted perimeters and longitudinal velocities) and statistical characteristics of turbulence for nominal geometric variants with spacers and without and the first results for a geometry disturbed by the parallel excursion of one rod in the peripheral line. The results were obtained at Reynolds number 4 x 10/sup 4/ to 2 x 10/sup 5/.

20369 (INIS-mf—10571, pp 121-132) **Experimental research of fuel element thermodynamics at UJV.** Sulc, V.; Masek, V.; Francak, S. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477. (CONF-8506335—Pt.1).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The major results are summed up of the experimental research of temperature inhomogeneities in the periphery of the fuel assembly of fast reactors in normal and disturbed geometry including the use of spacers. The dependences are given of hydrodynamic and thermodynamic parameters on the size and site of local blockage of the flow cross-section of the fuel assembly. The first results are described for lateral blockage in the model assembly of the BN-600 type.

## 2106 Power Reactors, Auxiliary, Mobile, Package, And Transportable

20370 (N—87-14422) **Electric propulsion options for the SP-100 reference mission.** Hardy, T.L.; Rawlin, V.K.; Patterson, M.J. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1987. 26p. (NASA-TM—88918; E—3343; NAS—1.15:88918; CONF-870102—11). NTIS, PC A03/MF A01.

From 4. symposium on space nuclear power systems; Albuquerque, NM, USA (12 Jan 1987).

Sponsored by the Inst. for Space Nuclear Power Studies.

Analyses were performed to characterize and compare electric propulsion systems for use on a space flight demonstration of the SP-100 nuclear power system. The component masses of resistojet, arcjet, and ion thruster systems were calculated using consistent assumptions and the maximum total impulse, velocity increment, and thrusting time were determined, subject to the constraint of the lift capability of a single Space Shuttle launch. From the study it was found that for most systems the propulsion system dry mass was less than 20 percent of the available mass for the propulsion system. The maximum velocity increment was found to be up to 2890 m/sec for resistojet, 3760 m/sec for arcjet, and 23 000 m/sec for ion thruster systems. The maximum thruster time was found to be 19, 47, and 853 days for resistojet, arcjet, and ion thruster systems, respectively.

## 2107 Regulation And Licensing

*REFER ALSO TO CITATION(S) 20324, 20411*

20371 (NUREG/CR—4613) **Evaluation of nuclear power plant operating procedures classifications and interfaces: Problems and techniques for improvement.** Barnes, V.E.; Radford, L.R. (Battelle Human Affairs Research Center, Seattle, WA (USA); Pacific Northwest Lab., Richland, WA (USA); Nuclear Regulatory Commission, Washington, DC (USA). Div. of Human Factors Technology). Feb 1987. Contract AC06-76RL01830. 119p. (PNL—5852; BHARC—400/86/008). NTIS, PC A06/MF A01 - GPO. File Number TI87006428.

This report presents activities and findings of a project designed to evaluate current practices and problems related to procedure classification schemes and procedure interfaces in commercial nuclear power plants. The phrase "procedure classification scheme" refers to how plant operating procedures are categorized and indexed (e.g., normal, abnormal, emergency operating procedures). The term "procedure interface" refers to how reactor operators are instructed to transition within and between procedures. The project consisted of four key tasks, including (1) a survey of literature regarding problems associated with procedure classifications and interfaces, as well as techniques for overcoming them; (2) interviews with experts in the nuclear industry to discuss the appropriate scope of different classes of operating procedures and techniques for managing interfaces between them; (3) a reanalysis of data gathered about nuclear power plant normal operating and off-

normal operating procedures in a related project, "Program Plan for Assessing and Upgrading Operating Procedures for Nuclear Power Plants"; and (4) solicitation of the comments and expert opinions of a peer review group on the draft project report and on proposed techniques for resolving classification and interface issues. In addition to describing these activities and their results, recommendations for NRC and utility actions to address procedure classification and interface problems are offered.

20372 **Progress for on-line acoustic emission monitoring of cracks in reactor systems.** Hutton, P.H.; Kurtz, R.J.; Friesel, M.A. (Battelle Pacific Northwest Labs., Richland, WA, USA). *Nuclear Engineering and Design;* **98**: No. 2, 135-140(Jan 1987). (CONF-8510173—). Contract AC06-76RL01830.

From 13. water reactor safety research information meeting; Gaithersburg, MD, USA (22 Oct 1985).

This paper reviews accomplishments and planned tasks for the NRC-sponsored research program concerned with "Acoustic Emission/Flaw Relationships for Inservice Monitoring of Nuclear Reactor Pressure Boudaries". The objective of the acoustic emission (AE) monitoring program is to develop and validate the use of AE methods for continuous surveillance of reactor pressure boundaries to detect flaw growth. Topics discussed include testing AE monitoring on reactors, refinement of an AE signal identification relationship, study of low crack growth rate effects on AE generation, and activity to produce an ASTM standard for AE monitoring and to gain ASME code acceptance of AE monitoring.

# 22 NUCLEAR REACTOR TECHNOLOGY

## 2201 Theory And Calculation

*REFER ALSO TO CITATION(S) 21661, 22060, 22063*

20373 **(CEA-CONF—8507) TRIPOLI calculation of the neutron field in the hall of the SILENE reactor.** Bourdet, L. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). May 1986. 6p. (In French). (CONF-8605216—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751022.

From 50. meeting of the French working group of dosimetry; Marcoule, France (21 May 1986).

This study concerns the utilization of the experimental reactor SILENE as radiation source. Its aim is to get a theoretical estimation of the neutron field characteristics in different points of the irradiation hall (spectra, fluences, equivalents of biological doses and reaction yields). These estimations are compared to results obtained by several experimental techniques; they allow to know better this neutron field with or without lead shield.

20374 **(CTA-IEAV-NT—07/85) Modification and testing of the code POLLA.** (Centro Tecnico Aeroespacial, Sao Jose dos Campos (Brazil). Inst. de Estudos Avancados). 12 Aug 1985. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700853.

The implantation and testing of POLLA computer code which translates the parameters of solved resonance for low energy neutrons by Reich-Moore formalism into the equivalent Adler-Adler ones are discussed. The POLLA computer code was developed by Nuclear Data Center of Instituto de Estudos Avancados, in Brazil, to solve actinide resonance cross sections.

20375 **(FEI—1629) Applicability study of the first collision probability method for calculation of cells with heavy shielded burnable poison rods.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1984. 22p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700866.

Applicability of fast-response algorithm of the first collision probability method for calculating the distribution of both one-group and multigroup neutron fluxes in multizone cylindrical cells was investigated. A modified technique and TESI calculation program are described. Resalts of calculations of cells with a highly shielded burnable poison rod are presented and analysis by comparison with results obtained with other methods is given. 16 refs.; 3 figs.; 4 tabs.

20376 **(FEI—1665) Reactor Ksub(eff) calculation using the albedo-diffusion approximation.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1985. 5p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700867.

The use of the albedo-diffusion approximation for the reactor Ksub(eff) calculation is considered. The calculation results of one-dimensional light-water reactors with infinite reflector in two-group albedo-diffusion and two-group Ssub(16) approximations are presented. Comparison of albedo-diffusion and Ssub(16) approximations shows that at not very small size of core albedo-diffusion approximation gives a high accuracy for a case of flat geometry, and in cylindrical and spherical geometries the relative error in Ksub(eff) value does not exceed 0.6 and 0.8% respectively. 7 refs.; 2 tabs.

20377 **(FEI—1668) Iterative selection principles for homogenized group constants.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1985. 30p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87700868.

A problem is considered on development of algorithms for selection principles for homogenizing group constants providing for the given group division, the conservation of the definite set of functionals of Ksub(eff) type, process numbers, fluxes and currents on the transition from the initial problem to the multigroup one with any preassigned accuracy limited certainly by indeterminancies of nuclear data. These algorithms can find the application for instance as algorithms of convolution of groups. 13 refs.

20378 **(ITEF—152(1985)) Calculation of neutron field distortion in a reactor on control rod displacement (IGR code).** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700982.

The realization of simulator software related to the development of calculation algorithm of spatial neutron field variation in control rod displacement is considered. The algorithm is realized in the IGR code for the BESM-6 computer. To decrease the calculations volume the algorithm for correction of effect function is suggested. 3 refs.

20379 **(JAERI-M—86-004) Sensitivity coefficients of reactor parameters in fast critical assemblies and uncertainty analysis.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1986. 95p. (In Japanese). NTIS (US Sales Only), PC A05/MF A01. File Number DE87701017.

Sensitivity coefficients of reactor parameters in several fast critical assemblies to various cross sections were calculated in 16 group by means of SAGEP code based on the generalized perturbation theory. The sensitivity coefficients were tabulated and the difference of sensitivity coefficients was discussed. Furthermore, the uncertainty of calculated reactor parameters due to cross section uncertainty were estimated using the sensitivity coefficients and cross section covariance data.

20380 **(KAERC—201/85) Experimental research on some reactor physics parameters in the enriched uranium-light water assembly.** (State Committee for Atomic Energy, Pyongyang (D.P.R. of Korea). Research Center for Atomic Energy.). 1985. 7p. (In Korean). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701471.

Reactor physics parameters of the 10% enriched uranium-light water assembly have been investigated. In this paper the measurement results of thermoutilization $\int$, resonant escape probability p and material buckling B/sup 2/ at lattice pitch range from 16 mm to 22m have been described experimentally.

## 2202 Components And Accessories

*REFER ALSO TO CITATION(S) 20424, 20913*

**20381 (EPRI-NP—5073) Caustic concentration in tube support plate crevices of steam generators: Topical report.** Brunet, J.P.; Campan, J.L. (Electric Power Research Inst., Palo Alto, CA (USA); CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). Mar 1987. 179p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920310.

The hideout of sodium hydroxide, sodium chloride and sodium carbonate was studied in a single tube model boiler at Cadarache. Radioactive $^{24}Na$ was used for the measurements in the drilled hole support plates. The crevices were empty or packed with magnetite or carbon fiber. Hideout increased with ppM-hours operation until the crevices were filled to a concentration of salt established by the available superheat and kinetic factors. As the gap in the crevice was reduced, the average concentration of caustic increased. Crevice solutions of 50% caustic were achieved after 700-1700 ppM-hours of operation with an available superheat (primary-secondary temperatures) of 65°C (117°F) in a 0.2 mm (8 mil) crevice packed with magnetite. Hideout return with no heat flux was shown to be an effective way to remove salts from the crevice.

**20382 (INIS-mf—10571, pp 67-76) Application of electromagnetic filtration in nuclear power plants and results of testing prototype filters.** Kysela, J.; Jindrich, K.; Fric, Z. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477. (CONF-8506335—Pt.1).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The types of ferrites which may occur in the coolant of the primary and secondary circuits are discussed as are the possibilities of installing electromagnetic filters in WWER nuclear power plants. The UJV Rez tried filtration using conventional ball bed of an electromagnetic filter on the RVS-2 loop. Also tested was the performance of a superconducting electromagnetic filter. A double-chamber electromagnetic filter was designed where each chamber forms an independent solenoid. This filter was tested on the RVS-3 loop. Filtration efficiency was 83% but it may be increased by suitable optimization. The size of trapped particles was not greater than 20 μm. The double-chamber electromagnetic filter was tested in the secondary circuit of the KKW Rheinsberg nuclear power plant. The test results are tabulated. (E.S.).

**20383 Steel containment buckling.** Butler, T.A.; Baker, W.E. (Los Alamos National Lab., NM, USA). *Nuclear Engineering and Design;* **98**: No. 2, 89-102(Jan 1987). (CONF-8510173—).

From 13. water reactor safety research information meeting; Gaithersburg, MD, USA (22 Oct 1985).

Two aspects of buckling of a free-standing nuclear containment building were investigated in a combined experimental and analytical program. In the first part of the study, the response of a scale model of a containment building to dynamic base excitation is investigated. A simple harmonic signal was used for preliminary studies followed by experiments with scaled earthquake signals as the excitation source. The experiments and accompanying analyses indicate that the scale model response to earthquake-type excitations is very complex and that current analytical methods may require that a dynamic capacity reduction factor be incorporated. The second part of the study quantified the effects of framing at large penetrations on the static buckling capacity of scale model containments. Results show little effect from the framing for the scale models constructed from the polycarbonate, Lexan. However, additional studies with a model constructed of the prototypic steel material are recommended.

**20384 HSST crack-arrest studies overview.** Pugh, C.E.; Whitman, G.D. (Oak Ridge National Lab., TN, USA). *Nuclear Engineering and Design;* **98**: No. 2, 141-147(Jan 1987). (CONF-8510173—). Contract AC05-84OR21400.

From 13. water reactor safety research information meeting; Gaithersburg, MD, USA (22 Oct 1985).

An overview is given of the efforts underway in the Heavy-Section Steel Technology (HSST) Program as of October 1985 to better understand and model crack-arrest behavior in reactor pressure vessel steels. The efforts are both experimental and analytical. The experimental work provides K/sub Ia/ data from laboratory-sized specimens, from thick-wall cylinders which exhibit essentially-full restraint and from nonisothermal wide-plate specimens. These data serve to define toughness-temperature trends and to provide validation data under prototypical reactor conditions. The analytical efforts interpret and correlate the data, plus provide LEFM, elastodynamic and viscoplastic analysis methods for analyzing crack run-arrest behavior in reactor vessels. The analysis methods are incorporated into finite element computer programs which are under development at three separate laboratories.

**20385 Elastodynamic fracture analysis of large crack-arrest experiments.** Bass, B.R.; Pugh, C.E.; Walker, J.K. (Oak Ridge National Lab., TN, USA). *Nuclear Engineering and Design;* **98**: No. 2, 157-169(Jan 1987). (CONF-8510173—). Contract AC05-84OR21400.

From 13. water reactor safety research information meeting; Gaithersburg, MD, USA (22 Oct 1985).

Recent elastodynamic fracture analysis results are summarized from Heavy-Section Steel Technology (HSST) studies in two major areas that related to assessing nuclear reactor pressure vessel integrity under pressurized-thermal-shock (PTS) conditions. These areas are crack run-arrest behavior in wide plates under nonisothermal conditions and fracture behavior of a thick-wall vessel under combined thermal and pressure loadings. The WP-1 series of HSST wide-plate crack-arrest tests are being performed at the National Bureau of Standards (NBS), Gaithersburg, MD, using specimens from HSST Plate 13A of A533 grade B class 1 steel. The six tests in the WP-1 series are aimed at providing crack-arrest data at temperatures up to and above that corresponding to the onset of the Charpy upper-shelf, as well as providing information on dynamic fracture (run and arrest) processes for use in evaluating improved fracture analysis methods. Elastodynamic analyses have been completed for the actual test conditions of the four tests, WP-1.1 through WP-1.4, conducted thus far in the WP-1 series. In this paper, the computed results are compared with data for crackline strain-time response, crack-propagation speed, arrest location and post-arrest tearing. The paper includes a summary of the arrest toughness calculations compiled in the four tests at temperatures that range from transition to upper-shelf values for the wide-plate material.

**20386 Computer modeling of lime-soda softening of cooling waters.** Chen, J.C.Y. Evanston, IL; Northwestern Univ. (1986). 245p. University Microfilms Order No. 85-23,294.

Thesis (Ph. D.).

A computer model is developed to fully describe the lime soda ash softening process. This process has a long history of being used to remove calcium and magnesium hardness from cooling waters in order to prevent scaling on heat exchangers. Softening of makeup water and/or a sidestream from the recirculating water will allow a reduction in blowdown. In the extreme case, zero blowdown may be accomplished to conserve cooling waters and to save the costs of disposing of blowdown. Cooling waters differ from most natural waters in having higher temperature and higher concentration of dissolved solids, and, therefore, a higher ionic strength. These factors plus the effects of complex formation are taken into consideration in the development of the computer model. To determine the composition of a softened water, the model assumes that an equilibrium state is reached in a reactor, and employs the equations of mass action and mass balance. The resulting nonlinear simultaneous equations are then linearized by Taylor series expansion and solved by the multidimensional Newton-Raphson method. The computer predictions are compared to the results of laboratory studies using synthetic waters.

## 2203 Fuel Elements

*REFER ALSO TO CITATION(S) 20141, 20915*

**20387** (IA—1421, pp 28-29) **Examination of filled nuclear fuel.** Henzel, V.; Ronen, Y. (Israel Atomic Energy Commission, Tel Aviv; Ben-Gurion Univ. of the Negev, Beersheba, Israel). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

**20388** **(IAE—4131/4) Stress-strained analysis of fuel rods taking into account anisotropy of properties of fuel and cladding materials.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1985. 17p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700881.

A technique and algorithm for the solution of the problem on the calculation of stress-strained state (SSS) of cylindrical fuel rods with rigid adhesion of fuel and cladding. To solve thr problem the theory of anisotropic thermoradioactive plasticity and creeping in increments is used. The calculation results of SSS fuel rods including sleeve core (UO/sub 2/) and cladding operating under stationary and nonstationary regimes of loading are presented. It is shown that the account of anisotropy of mechanical properties of fuel rod materials results in considerable differeces from SSS, obtained in a supposition on isotropy of fuel rod materials. 7 refs.; 7 figs.

**20389** **(INIS-mf—10572) Scientific conference proceedings. Session 2. Reactor materials.** Bartosek, V. (ed.). (Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia)). 1985. 42p. (In Czech). (CONF-8506335—Pt.2). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701473.

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The Reactor Materials session met on June 7, 1985 and heard 5 papers all of which were incorporated in INIS. The results were dealt with obtained in the determination of mechanical properties of fuel element cladding materials (Zr1Nb, Zircaloy-4) at increased fuel burnup as well as post-irradiation evaluation of components of DK 1-2 diagnostic assemblies for WWER reactors, the effects of neutron radiation on the microstructure and mechanical properties of zirconium alloys, the applications of neutron radiography, and the development of Ge(Li) detectors and high-purity germanium detectors. (E.S.).

**20390** **(JAERI-M—85-208) Evaluation of energy deposition in various test fuels in the NSRR experiments. Destructive energy measurement, Gd/sub 2/O/sub 3/-UO/sub 2/ and PuO/sub 2/-UO/sub 2/ test.** (Japan Atomic Energy Research Inst., Tokyo). Jan 1986. 59p. (In Japanese). NTIS (US Sales Only), PC A04/MF A01. File Number DE87701009.

New test series such as (i) destructive energy measurement, (ii) Gd/sub 2/O/sub 3/-UO/sub 2/ fuel and (iii) PuO/sub 2/-UO/sub 2/ fuel tests are in progress, and the conversion factors were evaluated by conducting the energy deposition calibration tests respectively. The fission numbers and energy deposition per core energy release determined through γ-ray spectrometry are as follows. (1) Destructive energy measurement tests: 6.29 x 10/sup 11/ f/gcenter dotUO/sub 2//MWs: 4.25 cal/gcenter dotUO/sub 2//MWs (2) Gd/sub 2/O/sub 3/-UO/sub 2/ fuel tests a. UO/sub 2/ fuel: 8.83 x 10/sup 11/ f/gcenter dotUO/sub 2//MWs: 5.96 cal/gcenter dotUO/sub 2//MWs b. Gd/sub 2/O/sub 3/-UO/sub 2/ fuel: 6.94 x 10/sup 11/ f/gcenter dotUO/sub 2//MWs: 4.69 cal/gcenter dotUO/sub 2//MWs (3) PuO/sub 2/-UO/sub 2/ fuel tests a. Phase 1: 3.77 x 10/sup 11/ f/gcenter dotUO/sub 2//MWs: 2.55 cal/gcenter dotUO/sub 2//MWs b. Phase 2: 3.51 x 10/sup 11/ f/gcenter dotUO/sub 2//MWs: 2.37 cal/gcenter dotUO/sub 2//MWs. In addition, an energy deposition in each test was derived from calculating the core energy release history. The energy deposition determined is useful not only to know the threshold of fuel failure but also to make comparison with that of standard tests.

**20391** **Hand-held optical fuel pin scanner.** Kirchner, T.L.; Powers, H.G. (to Dept. of Energy, Washington, DC). US Patent 4,637,718. 20 Jan 1987. Filed date 9 Dec 1980. vp.

A portable, hand-held apparatus is described for optically scanning indicia imprinted about a planar end face of an article having an outer wall surface, the apparatus comprising: a supporting frame; light detector means fixed to the frame for digitizing light patterns directed thereto; indexing means on the frame for engaging the planar end face and locating the end face in a preselected focal plane on the frame. The indexing means has an inner wall surface complementary to the article wall surface for disposition thereabout and terminates in an end portion beyond the planar end face. The inner wall surface has a radially inwardly extending shoulder spaced from the end portion and engageable with the planar end face; light means directed onto the preselected focal plane; optical means mounted on the frame about a central axis, the optical means being optically interposed between the indexing means and the light detector means for directing reflected light from the preselected focal plane to the light detector means and including a dove prism centrally aligned along the central axis; and means for selectively rotating the dove prism relative to the frame about the central axis to thereby rotate the image from the focal plane as transmitted to the light detector means.

## 2204 Control Systems

*REFER ALSO TO CITATION(S) 20440, 20444, 21023*

**20392** **(INIS-mf—10563) Contribution to design of algorithms for composite analysis and control of dynamical systems: Application to nuclear reactors.** (Commissariat aux Energies Nouvelles, Algiers (Algeria). Centre d'Etudes Nucleaires et Solaires). Jun 1986. 155p. (In French). NTIS (US Sales Only), PC A08/MF A01. File Number DE87701474.

This work concerns the study of decomposition methods of a continuous linear dynamical system in two decoupled or weakly coupled subsystems and the implementation of the corresponding algorithms. The interest of these methods is in the analysis and simulation of considered high dimensional system and its control low by designing a global controller based on two reduced order controlers designed independently (Composite control low). In the first part of this work are presented the existing techniques for the separation of slow and fast dynamics of physical model using singular perturbation theory. The interest of applying this theory to solve the linear quadratic optimal control problem is shown. A new method of decomposition of a dynamical system is proposed in the second part. This so called energetic method is formulated in a particular balanced state space representation of the system. The results obtained on the analysis of coupling between the resulting subsystems are presented. The elaboration of a composite low based on this new method is also studied. The two approaches of decomposition are respectively applied to models of nuclear reactors. The results obtained turned out to be conclusive.

**20393** **(INIS-mf—10564) Large scale systems approximation: Analysis and control.** (Commissariat aux Energies Nouvelles, Algiers (Algeria). Centre d'Etudes Nucleaires et Solaires). Oct 1986. 166p. (In French). NTIS (US Sales Only), PC A08/MF A01. File Number DE87701475.

This work concerns the study of the approximation of high dimensional systems by low order models. This approximation is defined by aggregation methods, the method based on singular perturbations and a relatively recent method. This later one is formulated in a particular representation of the system and is called balanced realisation method. The application of the approximation is then studied in the case of suboptimal control theory for the several defined models. The results of numerical simulation for the analysis and control are carried on two examples defined by a model of a nuclear reactor core of order nine and a steam generator of a fuel station of order twenty and permitted to develop a comparative study of the performances of the different methods analysed in the case of open loop and closed loop models.

20394 (INIS-mf—10571, pp 32-44) **In-pile measurements.** Erben, O.; Vasa, I.; Horinek, K. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477. (CONF-8506335—Pt.1).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

Research and application of in-pile sensors and the interpretation of signals from these sensors at UJV Rez are presented. Experiments carried out on the WWR-S research reactor are described dealing with the metrology of sensors, the monitoring of in-pile radiation parameters and the long-term comparison of parameters of sensors used for monitoring the research reactor and WWER nuclear power plant reactors. Work is described related to the study and application of self-powered detectors in the programme of diagnostic assemblies and the methods for performance testing of neutron sensors used for in-pile monitoring of WWER-440 nuclear power plant reactors.

20395 (INIS-mf—10571, pp 45-57) **Feedback effect of coolant flow fluctuations on neutron noise signals in experimental nuclear fuel assembly.** Vavrin, J. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477. (CONF-8506335—Pt.1).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The present state of experimental techniques using the instrumented fuel assembly of the WWER-440 nuclear reactor allowed to experiment with the harmonic and stochastic changes in single-phase and two-phase coolant flow. An analysis of the fluctuations of neutron noise signals showed a significant effect of thermohydrodynamic feedback in the low-frequency range up to 1 Hz. The global nature of the fluctuations allows to diagnose the condition of the fuel assembly from neutron noise signals of external ionization chambers. It is recommended that this knowledge be used in the diagnostic system to verify the performance of monitoring subsystems and for the introduction of active diagnosing of the condition of the reactor core.

20396 (JAERI-M—85-214) **Experiment on thermohydraulics of a simulated control rod. Test results of the control characteristics of the experimental facility.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1986. 28p. (In Japanese). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701010.

Since the cladding of the control rod of VHTR (Very High-Temperature gas-cooled Reactor) is metal, its design temperature is 850 deg C which is considerably low in comparison with the design temperature for graphite components. And the control rod has a complicated configuration in order to be inserted smoothly into the hole of the control rod block. Consequently, it is difficult to estimate the temperature of the cladding and the pressure loss of the cooling channel. For the study on the thermohydraulics of helium gas coolant in control rod channels, an experimental facility was manufactured. This report deals with test results on the characteristics in controling the flow rate, the gas temperature, and the gas pressure of the experimental facility. The good controllabilities were confirmed.

20397 (KFKI—1986-66/M) **Data presentation in the WWER-440 Basic Principle Simulator.** (Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics). Sep 1986. 17p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701478.

At the Central Research Institute for Physics, Budapest, Hungary, a Basic Principle Simulator for WWER-440 nuclear power plants is under development. The input/output subsystem of the simulator is described. This subsystem is a control desk-shaped special periphery representing each main parameter of the model. During development special attention was paid to the hardware support of the controllers as this part of the model is regarded as most time consuming. A short summary on the hardware configuration of the simulator is also presented. 5 figs.

## 2205 Environmental Aspects

*REFER ALSO TO CITATION(S) 20439*

20398 (INIS-BR—575) **Geological and geotechnical investigations for nuclear power plants sites.** (Minas Gerais Univ., Belo Horizonte (Brazil)). Sep 1984. 195p. (In Portuguese). NTIS (US Sales Only), PC A09/MF A01. File Number DE87700923.

This dissertation presents a general methodology for the tasks of geological and geotechnical investigations, to be performed in the proposed sites for construction of nuclear power plants. In this work, items dealing with the standards applied to licensing of nuclear power plants, with the selection process of sites and identification of geological and geotechnical parameters needed for the regional and local characterization of the area being studied, were incorporated. This dissertation also provides an aid to the writing of technical reports, which are part of the documentation an owner of a nuclear power plant needs to submit to the Comissao Nacional de Energia Nuclear, to fulfill the nuclear installation licensing requirements. Moreover, this work can contribute to the planning of field and laboratory studies, needed to determine the parameters of the area under investigation, for the siting of nuclear power plants.

20399 (INIS-mf—10570) **Prediction of environmental impact of power generation.** (Vyskumny Ustav Energeticky, Bratislava (Czechoslovakia)). 1985. 47p. (In Czech and Slovak). (CONF-8505340—Exc.). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701462.

From Prediction of environmental impact of power generation conference; Bratislava, Czechoslovakia (23 May 1985).

The proceedings contain 12 papers of which 4 were inputted in INIS. The papers deal with the impact of the construction and operation of nuclear power plants on the environment, with radiation hazards due to gaseous emissions and liquid effluents from nuclear power plants, the design and power utilization of the water management system for the nuclear power plant being designed in southern Slovakia, and the limits of radiation protection of nuclear sources in Czechoslovakia. (E.S.).

20400 (INIS-mf—10570, pp 110-118) **Nuclear power plants and the environment.** Moravek, J.; Stubna, M.; Feik, K.; Grujbar, V. 1985. (In Slovak). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701462. (CONF-8505340—Exc.).

From Prediction of environmental impact of power generation conference; Bratislava, Czechoslovakia (23 May 1985).

The radiation hazard is evaluated in the surroundings of nuclear power plants with PWR and BWR reactors from gaseous emissions and liquid effluents. Tables sum up data on the activity of the components of gaseous emissions, i.e., the radioactivity levels of rare gases, radioiodine, /sup 14/C and radioactive aerosols, and the corresponding exposure of the population in the surroundings of nuclear power plants with PWR reactors. Also given is the population exposure to tritium contained in liquid effluents. The development is evaluated of the radiation impact of nuclear power plants on the population living in nuclear power plant surrounds to the year 2000. (E.S.).

20401 (NUREG—0837-Vol.6-No.3) **NRC TLD [thermoluminescent dosimeters] Direct Radiation Monitoring Network: Progress report, July-September 1986.** Jang, J.; Rabatin, K.; Cohen, L. (Nuclear Regulatory Commission, King of Prussia, PA (USA). Region I). Feb 1987. 222p. NTIS, PC A10 - GPO. File Number DE87900536.

The US Nuclear Regulatory Commission (NRC) Direct Radiation Monitoring Network is operated by the NRC in cooperation with participating states to provide continuous measurement of the ambient radiation levels around licensed NRC facilities, primarily power reactors. Ambient radiation levels result from naturally occurring radionuclides present in the soil, cosmic radiation constantly bombarding the earth from outer space, and the contribution, if any, from the monitored facilities and other man-made sources. The Network is intended to measure radiation levels during routine facility operations and to establish background radi-

ation levels used to assess the radiological impact of an unusual condition, such as an accident. This report presents the radiation levels measured around all facilities in the Network for the second quarter of 1985. A complete listing of the site facilities monitored is included. In some instances, two power reactor facilities are monitored by the same set of dosimeters (e.g., Kewaunee and Point Beach).

## 2206 Research, Test, And Experimental Reactors

*REFER ALSO TO CITATION(S) 20373, 20390, 20394, 20726, 21706, 21707, 22048, 22081*

20402 **(CEA-CONF—8585) Operation of the OSIRIS reactor from the viewpoint of analysis of operator functions.** Fichet-Clairfontaine, P.Y.; Saint-Jean, T. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). Sep 1985. 36p. (In French and English). (CONF-8509357—1; CEA-DAS—221). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751035.

From Conference on analysis, design and evaluation of man-machine systems; Varese, Italy (10 Sep 1985).

This paper presents the results of analyses carried out on site by the Human Factor Study Laboratory in an experimental nuclear plant operated by the Atomic Energy Commissariat - the OSIRIS pool reactor. The analyses of certain tasks are given: work in the reactor hall and an operation of circuit setting performed by the mechanics. This work has thrown light on certain operational guidelines implemented by the operators when carrying out their work.

20403 **(EUR—10498) Operation of the High Flux Reactor. Annual report 1985.** (Commission of the European Communities, Petten (Netherlands). Joint Nuclear Research Center; Commission of the European Communities, Luxembourg). 1985. 26p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87701480.

This year was characterized by the end of a major rebuilding of the installation during which the reactor vessel and its peripheral components were replaced by new and redesigned equipment. Both operational safety and experimental use were largely improved by the replacement. The reactor went back to routine operation on February 14, 1985, and has been operating without problem since then. All performance parameters were met. Other upgrading actions started during the year concerned new heat exchangers and improvements to the reactor building complex. The experimental load of the High Flux Reactor reached a satisfactory level with an average of 57%. New developments aimed at future safety related irradiation tests and at novel applications of neutrons from the horizontal beam tubes. A unique remote encapsulation hot cell facility became available adding new possibilities for fast breeder fuel testing and for intermediate specimen examination. The HFR Programme hosted an international meeting on development and use of reduced enrichment fuel for research reactors. All aspects of core physics, manufacture technology, and licensing of novel, proliferation-free, research reactor fuel were debated.

20404 (IA—1421, pp 29-30) **Benchmarking codes for research reactor calculations.** Misulovin, A.; Schneider, A. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20405 **(IAE—1984/E-3/R/B) Measurement, control and stabilisation of the electric power of heaters in reactor rigs.** (Institute of Atomic Energy, Otwock-Swierk (Poland)). 1983. 13p. (In Polish). Power System Computer Centre, Mining and Power System Information Department, Palace of Culture and Science, PL-00-901 Warsaw, Poland.

Heat transfer investigations for reactor rigs development e.g. the thermal conductivity of the spray layers require the knowledge of the electric power level, control and stabilisation of this power. The stabilisation of the supply voltage is insufficient due to the variations of heater resistance caused by variable heat receipt. The circuits of the power measurement, control and stabilisation are described.

20406 (INIS-mf—10572, pp 25-40) **Advances of neutron radiography at UJV.** Hrdicka, Z. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701473. (CONF-8506335—Pt.2).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

Described are the neutron radiographic device placed at the WWR-S reactor at UJV Rez, a bar-shaped vertical positioner of objects, and a device developed for the direct evaluation of the attenuation of neutron flux intensity in different points of the cross section of the radiography beam. Neutron radiography is used for nondestructive diagnostics of fuel elements. Methods are presented of determining the diameter of the fuel pellet using an analysis of the densitographic function and of determining the total macroscopic effective cross section of UO/sub 2/ pellets. In the building industry, neutron radiography is used for assessing the volume of free and bound water, and its use is planned for monitoring the movement and content of water and hydrogen-containing substances in composite building materials. (E.S.).

20407 **(INR—1949/9/R/B) Analysis of the operating conditions of the shielding block for the KAMA - type reactor rigs.** (Institute of Nuclear Research, Warsaw (Poland)). 1982. 33p. (In Polish). Power System Computer Centre. Mining and Power System Information Department, Palace of Culture and Science, PL-00-901 Warsaw, Poland.

A method of the complex analysis of the shielding block for the thermostatic reactor rigs is described. The main aim of analysis is to determine the temperature field in the block and its influence on the operation of the rig. The complexity of the problem and a lack of calculation procedures necessitate the introduction of simplification into the model and the use of approximate calculation methods. The behaviour of the shielding block during the experiment in the reactor and the partial measurement results prove the correctness both of the shielding block design and of the method of analysis. These results allow the use of the block for the thermostatic reactor rigs as the irradiation channel in the reactor MARIA.

20408 **(JAERI-M—86-007) Surveillance test of the JMTR core components.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1986. 71p. (In Japanese). NTIS (US Sales Only), PC A04/MF A01. File Number DE87701020.

Surveillance test for the core components of Japan Materials Testing Reactor (JMTR) was started in 1966, and completed in 1985 without one capsule. Most of capsules in the program, except one beryllium specimens, were removed from the core, and carred out the post-irradiation tests at the JMTR Hot Laboratory. The data is applied to review of JMTR core components management plan. JMTR surveillance test was carried out with several kind of materials of JMTR core components, berylium as the reflector, hafnium as the neutron absorber of control rod, 17-4PH stainless steel as a roller spring of the control rod, and 304 stainless steel as the grid plate. Results are described in this report.

20409 **(JAERI-M—86-012) Annual progress report on the NSRR experiments, 16. January 1984 through December 1984.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1986. 191p. (In Japanese). NTIS (US Sales Only), PC A09/MF A01. File Number DE87701023.

Fuel behavior studies in simulated reactivity initiated accident (RIA) conditions have been performed by utilizing Nuclear Safety Research Reactor (NSRR) since October, 1975. This report describes the results obtained from January through December, 1984. A total of 62 tests were carried out during this period; those are 6 fuel design parameter tests (2 long-sized fuel rod tests, 4 pre-irradiated clad fuel rod tests), 3 cooling condition parameter tests (2 forced convection tests and 1 bundle rod test), 4 defected fuel rod tests (4 fretting corroded clad fuel rod tests), 3 severe fuel damage tests, 18 special fuel rod tests (2 HTGR fuel tests, 5 mixed oxide fuel rod tests, 11 Gd/sub 2/O/sub 3/-UO/sub 2/ fuel rod tests), 18

miscellaneous atomspheric pressure capsule tests (mechanical energy measurement tests, fuel rod deformation measurement tests, etc), 4 high temperature high pressure capsule tests, 2 high temperature high pressure loop tests and 4 fuel behavior observation tests.

## 2207 Plutonium And Isotope Production Reactors

*REFER ALSO TO CITATION(S) 22048*

**20410 Californium-252: Properties and production.** Keller, O.L. (Oak Ridge National Lab., Oak Ridge, TN 37831). *Nuclear Science Applications;* **2**: No. 3, 263-271(1986). Contract AC05-84OR21400.

Production of Californium-252 (/sup 252/Cf) is carried out in the High Flux Isotope Reactor (HFIR) at the Oak Ridge National Laboratory. The chemical separation and purification of the Cf is made in the adjacent Transplutonium Processing Plant (TRU). The HFIR/TRU is the sole source for /sup 252/Cf in the western world. There is also an important but smaller production facility located in Dimitrovgrad in the USSR.

## 2208 Propulsion Reactors

*REFER ALSO TO CITATION(S) 20370, 22026*

## 2209 Reactor Safety

*REFER ALSO TO CITATION(S) 20371*

**20411 (CEA-CONF—8587) Obligations and characteristics applicable to the French unit of the 1400 MWe series. Adaptation to the 900 and 1300 MWe series.** Conte, M. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). Oct 1985. 13p. (In French). (CONF-851079—2; CEA-DAS—209). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751034.

From 9. international conference on modern power stations; Liege, Belgium (7 Oct 1985).

This report presents the directives concerning the obligations and the main characteristics of the nuclear PWR units of 1400 MWe, notified Electricite de France on the 6th of October 1983 by the Industry and Research Department. They reflect the concept of defence in depth.

**20412 (CEA-CONF—8588) Main problems met with the emergency diesel generators of French PWRs 900 MWe.** Dredemiş, G.; Jude, F. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). Oct 1985. 9p. (In French). (CONF-8510221—3; CEA-DAS—215). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751030.

From Committee on the Safety of Nuclear Installations (CSNI) specialist meeting on operating experience relating to on-site electric power sources; London, UK (16 Oct 1985).

Each unit of all the French nuclear power plant is equipped with two diesel emergency generator sets. For the totality of standardized PWRs of 900 MWe, they are identical. We present in this communication the most significative failures met with diesel engines on operating units, such as rupture of fuel injection pipes, breaking of the connecting rods, and cylinder lubrification failures. All these incidents, which affected the emergency power sources of concerned units, had generic characteristics. In view of their potential consequences, it was proceeded in each case to an immediate control of the components concerned of all PWR 900 MWe diesel engines. At the same time, studies were started as to what modifications would permit to solve rapidly each one of the problems met with.

**20413 (CEA-CONF—8589) On-site AC electric power sources for 900 MWe French nuclear power reactors: reliability and importances for safety.** Milhem, J.L.; Gros, G. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). Oct 1985. 13p. (CONF-8510221—2; CEA-DAS—216). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751029.

From Committee on the Safety of Nuclear Installations (CSNI) specialist meeting on operating experience relating to on-site electric power sources; London, UK (16 Oct 1985).

After presenting briefly the new provisions laid down by the Electricite de France to meet a total electrical power loss, the main elements of the probabilistic study concerning the corresponding risk are described: reliability data of internal sources used, results of risk improvement brought by the new measures, importance for internal source before and after implementation of the new measures.

**20414 (CEA-CONF—8590) Some failures of diesel generators during commissioning tests of 1300 MWe PWR.** Colas, A.F.; Morzelle, C. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). Oct 1985. 18p. (CONF-8510221—4). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751031.

From Committee on the Safety of Nuclear Installations (CSNI) specialist meeting on operating experience relating to on-site electric power sources; London, UK (16 Oct 1985).

During commissioning tests of the French 1300 MWe units, which are equipped with different diesel generator from the 900 MWe units, some devices and components failures were experienced. These components include: Alarm sensors on fuel, lubricating, cooling circuits; Injection pumps and speed governors; Fuel delivery; Vibrations of fuel and lubrication lines. This paper shows how and when the above elements can affect the reliability of Diesel-generator units and how commissioning tests should show the defects.

**20415 (CEA-IPSN—2-Rev.2) Chernobyl accident.** (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Protection et de Surete Nucleaire). Jun 1986. 162p. (In French). NTIS (US Sales Only), PC A08/MF A01. File Number DE87751036.

First, R.M.B.K type reactors are described. Then, safety problems are dealt with reactor control, behavior during transients, normal loss of power and behavior of the reactor in case of leak. A possible scenario of the accident of Tchernobyl is proposed: events before the explosion, possible initiators, possible scenario and events subsequent to the core meltdown (corium-concrete interaction, interaction with the groundwater table). An estimation of the source term is proposed first from the installation characteristics and the supposed scenario of the accident, and from the measurements in Europe; radiological consequences are also estimated. Radioactivity measurements (Europe, Scandinavia, Western Europe, France) are given in tables (meteorological maps and fallouts in Europe). Finally, a description of the site is given.

**20416 (CEA-IPSN-RA—1985) 1985. Annual progress report.** (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Protection et de Surete Nucleaire). 1986. 168p. (In French). NTIS (US Sales Only), PC A08/MF A01. File Number DE87751043.

This annual progress report of the CEA Protection and Nuclear Safety Institut outlines a description of the progress made in each sections of the Institut Research activities of the different departments include: reactor safety analysis, fuel cycle facilities analysis; and associated safety research programs (criticality, sites, transport ...), radioecology and environmental radioprotection techniques; data acquisition on radioactive waste storage sites; radiation effects on man, studies on radioprotection techniques; nuclear material security including security of facilities, security of nuclear material transport, and monitoring of nuclear material management; nuclear facility decommissioning; and finally the public information.

20417 **(CONF-861102—39) Impacts of reactivity feedback uncertainties on inherent shutdown in innovative designs.** Mueller, C.J. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 7p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87004741.

From American Nuclear Society and Atomic Industrial Forum joint meeting; Washington, DC, USA (16 Nov 1986).

The concept of "inherent shutdown" is emphasized in the approach to the design of innovative, small pool-type liquid metal reactors (LMRs). This paper reports an evaluation of reactivity feedback uncertainties used in the analyses of anticipated transients without scram (ATWS) for innovative LMRs, and the associated impacts on safety margins and inherent shutdown success probabilities on unprotected loss-of-flow (LOF) events. It then assesses the ultimate importance of these uncertainties on LOF and transient overpower (TOP) events in evolving metal and oxide innovative designs.

20418 **(CONF-861204—6) Effect of boiling regime on melt stream breakup in water.** Spencer, B.W.; Gabor, J.D.; Cassulo, J.C. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 18p. NTIS MF A01; 2; GPO Dep. File Number DE87004705.

From 4. Miami international symposium on multi-phase transport and particulate phenomena; Miami Beach, FL, USA (15 Dec 1986).

A study has been performed examining the breakup and mixing behavior of an initially coherent stream of high-density melt as it flows downward through water. This work has application to the quenching of molten core materials as they drain downward during a postulated severe reactor accident. The study has included examination of various models of breakup distances based upon interfacial instabilities dominated either by liquid-liquid contact or by liquid-vapor contact. A series of experiments was performed to provide a data base for assessment of the various modeling approaches. The experiments involved Wood's metal (T/sub m/ = 73°C, rho = 9.2 g/cm$^3$, d/sub j/ = 20 mm) poured into a deep pool of water. The temperature of the water and wood's metal were varied to span the range from single-phase, liquid-liquid contact to the film boiling regime. Experiment results showed that breakup occurred largely as a result of the spreading and entrainment from the leading edge of the jet. However, for streams of sufficient lengths a breakup length could be discerned at which there was no longer a coherent central core of the jet to feed the leading edge region. The erosion of the vertical trailing column is by Kelvin-Helmoltz instabilities and related disengagement of droplets from the jet into the surrounding fluid. For conditions of liquid-liquid contact, the breakup length has been found to be about 20 jet diameters; when substantial vapor is produced at the interface due to heat transfer from the jet to the water, the breakup distance was found to range to as high as 50 jet diameters. The former values are close to the analytical prediction of Taylor, whereas the latter values are better predicted by the model of Epstein and Fauske.

20419 **(EUR—10402) Plasma arc and thermal lance techniques for cutting concrete and steel.** Bargagliotti, A.; Caprile, L.; Piana, F.; Tolle, E. (Commission of the European Communities, Luxembourg). 1986. 174p. NTIS (US Sales Only), PC A08/MF A01. File Number DE87751016.

The plasma arc technique is used today in industrial practice for any metal, but mainly for cutting stainless steel, carbon steel and aluminium. In air the maximum thickness that was cut in the performed tests was 150 mm, both with ferritic and austenitic steel. Underwater the maximum thickness cut was 103 mm. The two types of torch used in the tests are those used today: the plasma-shaped electrode torch (WIPC) and the pointed electrode torch (DMC-GRUEN). Two different types of gas were compared: an argon-nitrogen mixture and an argon-hydrogen mixture. The second mixture adopted results in less dust emission. The production of dust and aerosols also depends on the cutting speed, on the kind of steel, but mainly on the environmental conditions; it is reduced up to 500 times under water. Dust and aerosols can, jeopardize the efficiency of the system; moreover, the ambient air can have high-level radiation fields. Indirect and direct protections are needed (shields, remote control, robots, etc.). Tentative procedures for dismantling two types of BWR reactor are examined. Two series of tests demonstrated the feasibility of cutting the most geometrically difficult parts of the reactor internals. The thermal lance technique is used in industrial practice mainly for dismantling large reinforced concrete structures. This technique can be applied to dismantle nuclear facilities, even though it can cause some problems due to the gases, fumes and lapilli produced. In addition, the cost of this technique seems to be generally higher than the cost of other techniques. From the analyses done, the conclusion seems that both the above techniques are feasible for dismantling a nuclear power plant (NPP). The best solution is probably to analyse the different dismantling possibilities and problems and problems of each case.

20420 **(FRADOC—8-8) Flaw analysis in steam generator tube.** Hutin, J.P.; Billon, F. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Aug 1985. 12p. (CONF-850828—4). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750998.

From 4. international seminar on assuring structural integrity of steel reactor pressure boundary components; Ispra, Varese, Italy (26 Aug 1985).

Operating more than 30 PWR units, Electricite de France has to face several steam generator tube problems. One of the most serious difficulties is the stress corrosion cracking due to primary fluid, just above the tube sheet, in the roll transition region. With regard to availability it is, of course, a major concern; with regard to safety, the point is that tube rupture should be preceded by a significant primary-to-secondary leak during normal operation so that the reactor should be shut down before failure occurs. The demonstration of this assessment asks for experimental and analytical evidences. In 1981, Elecricite de France started a comprehensive program on that subject. A general description of this program and the main results are to be presented during the SMIRT-8 Conference. The purpose of the present paper is to develop in greater detail the analytical part of the work.

20421 **(FRADOC—9-5) Experience of partial dismantling of French PWR and engineering features to facilitate decommissioning.** Dubourg, M. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Jul 1985. 17p. (CONF-850720—6). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751004.

From International nuclear reactor decommissioning planning conference; Bethesda, MD, USA (16 Jul 1985).

Under the auspices of Electricite de France, a feasibility study was performed concerning the dismantling of four PWR units and the on site entombment of the active components into a reactor containment building. An evaluation of activity and radwaste volume has been done. Regarding the relatively youthness of FRAMATOME PWR's in operation no decommissioning operation is scheduled before 1992. However in the past, FRAMATOME has gained practical experience related to partial dismantling of active components of nuclear reactors. The 1st reported experience is related to the thermal shield removal of the 1st PWR in operation in France, and the second example is related to the replacement of centering pins of control rod guide tube of some 900 MWe PWR's. To facilitate decommissioning, and to reduce the activation and contamination, a strict control of materials submitted to neutron flux is performed and, some practical measures have been taken at the design stage and during operation for minimizing the residual contamination of surfaces. To facilitate future dismantling operations, one takes into account, the possible replacement of large components at the design stage, several features of the plant lay out have been defined, and the documentation of the plant has to be correctly updated.

20422 (IA—1421, pp 179-180) **Effectiveness of protective measures in reducing the radiological effects due to an accident in a nuclear power plant.** Koch, J.; Tadmor, J. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.

In Research laboratories annual report 1985.

20423 (IA—1421, pp 136-137) **Mass removal of noncondensing constituents from a gas-vapor mixture by film condensation.** Ketter, A.; Wacholder, E.; Elias, E. (Israel Atomic Energy Commission, Tel Aviv; Technion-Israel Inst. of Tech., Haifa). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20424 (IA—1421, pp 21-22) **Sensitivity of the pressurizer response to PORV setting under simulated accident conditions.** Saphier, D. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20425 (IA—1421, pp 19) **Some safety aspects of modular HTGR.** Szabo, J.; Greenspan, E. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20426 (IKE—4-123) **KESS-2, a system for simulation of core melt accidents. Final report.** Scheuermann, W.; Bleher, G.; Schmidt, F.; Bisanz, R.; Hocke, K.D.; Mayr, P. (Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme). Sep 1986. 112p. (In German). NTIS (US Sales Only), PC A06/MF A01. File Number DE87751290.

KESS was able to simulate core melt accidents resulting from a 2 F break (low pressure cases). Risk studies and the accident at TMI-2 have revealed that this is not sufficient. Therefore it was decided to further develop the KESS system. The result is KESS-2. One can treat general accident situations with the new system. Thermalhydraulic conditions can be determined either by special programs or by a primary circuit model which is part of KESS-2. Due to the use of advanced software technologies it became possible to utilize the KESS-2 system in two different ways. Models and program sequences are provided for standard accident sequences as defined in the German Risk Study Phase B. They may be parameterised or adapted to different conditions. This can be done in a way similar to the use of conventional programs. Due to the modular design of KESS-2 it is also possible to use the system as a tool which allows to react on new situations. However this requires an understanding of both, the physics and the models provided in KESS-2. Both ways to utilise KESS-2 are demonstrated by several examples.

20427 (INIS-mf—10294) **Experimental investigations on fission product release (especially iodine and cesium) at design basis accidents. Part 1. Final report.** Neeb, K.H.; Morell, W.; Richter, F.; Haas, E.; Kastner, W.; Rippel, R.; Roebig, G.; Ahrens-Botzong, R. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). Apr 1984. 160p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87751281.

By way of large-scale pressure release tests, the carry-over of non-volatile fission products (I,Cs) by droplets dissolved in PWR coolant after differential pressure line failure in the annulus was measured. In order to simulate the fission product carry-over, cesium ions (CsNO/sub 3/) were used as tracer material. The cesium carry-over was distinctly below 0.5% as compared to the cesium amount which had entered the ruptured area. The results show that the calculatory basis outlined in the regulatory guide lines of the Federal Ministry of the Interior considerably overestimate the iodine and cesium fission product release.

20428 (INIS-mf—10549) **Onset of nuclear boiling in forced convection (Method of detection).** (Commissariat aux Energies Nouvelles, Algiers (Algeria). Centre d'Etudes Nucleaires et Solaires). Jan 1986. 72p. (In French). NTIS (US Sales Only), PC A04/MF A01. File Number DE87701464.

Local onset of boiling in any pressure water cooling systems, as a PWR for instance, can mean a possible dangerous mismatch between the produced heat and the cooling capabilities. Its consequences can lead to serious accidental conditions and a reliable technique to detect such a phenomenon is therefore of particular need. Most techniques used up to now rely basically on local measurements and assume therefore usually the previous knowledge of the actual hot or boiling spot. The method proposed here based on externally located accelerometers appears to be sensitive to the global behaviour of the mechanical structure and is therefore not particularly bound to any exact localization of the sensors. The vibrations produced in the mechanical structure of the heated assembly are measured by accelerometers placed on the external surfaces that are easily accessible. The onset of the boiling, the growth and condensation of the bubbles on the heated wall, induces a resonance in the structure and an excitation at its particular eigen frequencies. Distinctive peaks are clearly observed in the spectral density function calculated from the accelerometer signal as soon as bubbles are produced. The technique is shown to be very sensitive even at the earliest phase of boiling and quite independent on sensor position. A complete hydrodynamic analysis of the experimental channels have been performed in order to assess the validity of the method both in steady conditions and during rapid power transients.

20429 (INIS-mf—10566) **Radiation protection measurements at Paks and its surroundings after the accident of the Chernobylsk nuclear power plant from 28 April 1986.** (Paksi Atomeroemue Vallalat (Hungary)). Aug 1986. 50p. (In Hungarian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701461.

Experimental data on the contaminantion measured within a radius of 30 km from the Paks Nuclear Power Plant due to the accident of the Chernobylsk-4 reactor are given for the period between 28 April and 13 June 1986. Measurements on airborne and fallout activities, surface contamination of the ground, dose rates of γ radiation, activity concentration of the Danube, of milk, plant and food samples and the activity of human thyroid gland were carried out in the environmental control lab of the Paks NPP. According to the preliminary dose calculations the increment of the radiation exposure of the population is regarded to mount up to the average dose burden for half a year due to natural environmental radiation. (V.N.). 5 refs.

20430 (INIS-mf—10571, pp 5-15) **Thermal-hydraulic and thermomechanical analyses of PWR core.** Dienstbier, J.; Pazdera, F.; Valach, M. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477. (CONF-8506335—Pt.1).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

A survey is presented of work in the field of thermal-hydraulic analysis of PWR cores and the determination of hot site and hot channel factors, the field of thermomechanical analysis of the behaviour of the fuel element during normal operation and in accident situations, mainly in LOCA type accidents. The studies cover the development, modification and verification of own or assumed computer programs, namely the COBRA, VEVERKA, SCENE, PIN, GARPCON-THERMAL-3, FRAS and SSYST-2 programs and participation in the IAEA controlled international research program D-COM. All studies presented are oriented to the analysis of PWR nuclear power plant safety.

20431 (INIS-mf—10571, pp 27-31) **Reliability analyses of safety systems for WWER-440 nuclear power plants.** Dusek, J.; Hojny, V. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A07/MF A01. File Number DE87701477. (CONF-8506335—Pt.1).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The UJV in Rez near Prague studied the reliability of the system of emergency core cooling and of the system for suppressing pressure in the sealed area of the nuclear power plant in the occurrence of a loss-of-coolant accident. The reliability of the systems was evaluated by failure tree analysis. Simulation and analytical calculation programs were developed and used for the reliability analysis. The results are briefly presented of the reliability analyses of the passive system for the immediate short-term flooding of

the reactor core, of the active low-pressure system of emergency core cooling, the spray system, the bubble-vacuum system and the system of emergency supply of the steam generators. (E.S.).

20432 **(JAERI-M—85-219) Assessment of TRAC-PF1/MOD1 for countercurrent - annular and stratified flows.** (Japan Atomic Energy Research Inst., Tokyo). Jan 1986. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701013.

I performed an independent assessment of the Transient Reactor Analysis Code, TRAC-PF1/MOD1, using air-water countercurrent-flow limitation data in circular pipes for annular, annular-mist, and stratified flows. Tubes were configurated in the vertical direction with different lengths and diameters and at angles of 60 deg, 40 deg, 20 deg, and 0 deg from the horizontal, respectively. Also, comparisons were made with data from a horizontal tube with an inclined riser at the end that simulated a pressurized water reactor (PWR) hot leg. TRAC-PF1/MOD1 was modified to study the effects of using two different correlations for interfacial shear in the annular-mist flow regime: the Wallis and Bharathan correlations. TRAC-PF1/MOD1 with the Wallis correlation predicts the point of no water penetration (bypass point) in the annular-mist flow regime except for the 40 deg inclined tube. However, for the region of partial water penetration, use of the Bharathan correlation in TRAC-PF1/MOD1 gives better agreement with data. Additional form losses were required at both ends of the tube to predict the flow rate of falling water accurately for the vertical tube. In the stratified-flow regime, TRAC-PF1/MOD1 underpredicts the air velocity which gives the bypass point but gives good agreement for the region of partial penetration. For the case of a simulated PWR hot leg, the code yields similar results to those obtained for the stratified-flow regime.

20433 **(NUREG/CP—0082-Vol.1) Proceedings of the US Nuclear Regulatory Commission fourteenth water reactor safety information meeting: Volume 1, Plenary session, Severe accident sequence analysis, Risk analysis/PRA applications, Reference plant risk analysis - NUREG-1150, Innovative concepts for increased safety of advanced power reactors.** Weiss, A.J. (comp.). (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA)). Feb 1987. 516p. (CONF-8610135—Vol.1). NTIS, PC A22/MF A01 - GPO. File Number TI87005722.

From 14. water reactor safety information meeting; Gaithersburg, MD, USA (27 Oct 1986).

This six-volume report contains 156 papers out of the 175 that were presented at the Fourteenth Water Reactor Safety Information Meeting held at the National Bureau of Standards, Gaithersburg, Maryland, during the week of October 27-31, 1986. The papers are printed in the order of their presentation in each session and describe progress and results of programs in nuclear safety research conducted in this country and abroad. Foreign participation in the meeting included thirty-four different papers presented by researchers from Canada, Czechoslovakia, Finland, Germany, Italy, Japan, Mexico, Spain, Sweden, Switzerland and the United Kingdom. The titles of the papers and the names of the authors have been updated and may differ from those that appeared in the final program of the meeting.

20434 **(NUREG/CP—0082-Vol.2) Proceedings of the US Nuclear Regulatory Commission fourteenth water reactor safety information meeting: Volume 2, Research in nondestructive evaluation, Environmental effects in primary system components, Pressure vessel research, Irradiation effects on RPV steels, Degraded piping research.** Weiss, A.J. (comp.). (Brookhaven National Lab., Upton, NY (USA); Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research). Feb 1987. Contract AC02-76CH00016. 438p. (CONF-8610135—Vol.2). NTIS, PC A19/MF A01 - GPO. File Number TI87005805.

From 14. water reactor safety information meeting; Gaithersburg, MD, USA (27 Oct 1986).

This six-volume report contains 156 papers out of the 175 that were presented at the fourteenth Water Reactor Safety Information Meeting held at the National Bureau of Standards, Gaithersburg, Maryland, during the week of October 27 to 31, 1986. The papers are printed in the order of their presentation in each session and describe progress and results of programs in nuclear safety research conducted in this country and abroad. Foreign participation in the meeting included thirty-four different papers presented by researchers from Canada, Czechoslovakia, Finland, Germany, Italy, Japan, Mexico, Spain, Sweden, Switzerland and the United Kingdom. The titles of the papers and the names of the authors have been updated and may differ from those that appeared in the final program of the meeting.

20435 **(NUREG/CP—0082-Vol.3) Proceedings of the US Nuclear Regulatory Commission fourteenth water reactor safety information meeting: Volume 3, Equipment qualification, Mechanical and structural research, Seismic research, Nuclear plant aging.** Weiss, A.J. (comp.). (Brookhaven National Lab., Upton, NY (USA); Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research). Feb 1987. Contract AC02-76CH00016. 428p. (CONF-8610135—Vol.3). NTIS, PC A19/MF A01 - GPO. File Number TI87005959.

From 14. water reactor safety information meeting; Gaithersburg, MD, USA (27 Oct 1986).

The six-volume report contains 156 papers out of the 175 that were presented at the Fourteenth Water Reactor Safety Information Meeting held at the National Bureau of Standards, Gaithersburg, Maryland, during the week of October 27 to 31, 1986. The papers are printed in the order of their presentation in each session and describe progress and results of programs in nuclear safety research conducted in this country and abroad. Foreign participation in the meeting included thirty-four different papers presented by researchers from Canada, Czechoslovakia, Finland, Germany, Italy, Japan, Mexico, Spain, Sweden, Switzerland and the United Kingdom. The titles of the papers and the names of the authors have been updated and may differ from those that appeared in the final program of the meeting.

20436 **(NUREG/CP—0082-Vol.6) Proceedings of the US Nuclear Regulatory Commission fourteenth water reactor safety information meeting: Volume 6, TMI-2 analyses, Fission product release and transport in containment, Severe accident source term, Containment systems research/containment loads analysis.** Weiss, A.J. (comp.). (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA)). Feb 1987. Contract AC02-76CH00016. 420p. (CONF-8610135—Vol.6). NTIS, PC A18/MF A01 - GPO. File Number TI87005860.

From 14. water reactor safety information meeting; Gaithersburg, MD, USA (27 Oct 1986).

This six-volume report contains 156 papers out of the 175 that were presented at the Fourteenth Water Reactor Safety Information Meeting held at the National Bureau of Standards, Gaithersburg, Maryland, during the week of October 27 to 31, 1986. The papers are printed in the order of their presentation in each session and describe progress and results of programs in nuclear safety research conducted in this country and abroad. Foreign participation in the meeting included thirty-four different papers presented by researchers from Canada, Czechoslovakia, Finland, Germany, Italy, Japan, Mexico, Spain, Sweden, Switzerland and the United Kingdom. The titles of the papers and the names of the authors have been updated and may differ from those that appeared in the final program of the meeting.

20437 **(SAND—86-2500C) Risk uncertainty analysis methods for NUREG-1150.** Benjamin, U.S.; Boyd, G.J. (Sandia National Labs., Albuquerque, NM (USA); Safety and Reliability Optimization Services, Knoxville, TN (USA)). 1986. Contract AC04-76DP00789. 25p. (CONF-8610135—60). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002057.

From 14. water reactor safety information meeting; Gaithersburg, MD, USA (27 Oct 1986).

Evaluation and display of risk uncertainties for NUREG-1150 constitute a principal focus of the Severe Accident Risk Rebaselining/Risk Reduction Program (SARRP). Some of the principal objectives of the uncertainty evaluation are: (1) to provide a quanti-

tative estimate that reflects, for those areas considered, a credible and realistic range of uncertainty in risk; (2) to rank the various sources of uncertainty with respect to their importance for various measures of risk; and (3) to characterize the state of understanding of each aspect of the risk assessment for which major uncertainties exist. This paper describes the methods developed to fulfill these objectives.

20438 **Safety-related topics from the Nuclear Power Options Viability Study.** Trauger, D.B.; White, J.D. (Oak Ridge National Lab., TN). *Nuclear Safety;* **27**: No. 4, 467-475(Oct-Dec 1986).

The Nuclear Power Options Viability Study (NPOVS) evaluated innovative reactor concepts, and this article reviews NPOVS findings, with emphasis on safety and licensing. The reactors studied were of light-water, liquid-metal, and helium-cooled concepts, and most were of modular design. Prelicensed standard plants offer an important step toward regulatory stability and early licensing approvals with public participation before major expenditures. Advanced reactors with passive safety features offer the possibility of performance-based regulation. The concepts studied appear to be potentially viable, but more complete designs will be required before economic evaluations can be definitive.

20439 **Seismic hazard characterization for the eastern US.** Savy, J.B.; Bernreuter, D.L.; Mensing, R.W. (Lawrence Livermore National Lab., CA). *Nuclear Safety;* **27**: No. 4, 476-487(Oct-Dec 1986).

The eastern US seismic hazard characterization project sought to develop a methodology and a data base for calculating the hazard at any site east of the Rocky Mountains. The basic characteristic of the methodology is the use of experts' opinions to supplement the sparse and often low-quality seismicity and ground-motion data available. It also recognizes the uncertainties associated with hazard analyses. A simulation technique is used to develop a probability distribution of the hazard that describes the uncertainty in the hazard caused by uncertainty in the source zonation maps, the ground-motion models, the earthquake recurrence modeling, and the maximum magnitude possible in each source zone. (Uncertainty is presented in terms of envelopes of percentile curves for the peak ground acceleration and for 5% damping spectral values.) The study found the largest contributor to the uncertainty in the final hazard to be caused by the uncertainty in the ground-motion predictions; diversity of experts' opinions, source zonation, and seismicity parameters, respectively, followed in importance.

20440 **Review of trends in computerized systems for operator support.** Cain, D.G. (Electric Power Research Institute, Palo Alto, CA). *Nuclear Safety;* **27**: No. 4, 488-498(Oct-Dec 1986).

This article examines past, present, and future trends in the development of computerized operator support systems. Previous research in disturbance analysis systems and the safety parameter display systems requirement were instrumental in the development of computerized operator support systems. Work today shows the trend toward increased hardware capability, attention to signal quality, event independence, display-procedures integration, improved design methodologies, on-line analysis capability, standardization, and office automation. Although the future is difficult to predict, one trend will be toward more intelligent software.

20441 **Ranking of design and operational alternatives for the mitigation and avoidance of sabotage in nuclear power plants.** Tabatabai, A.S.; Andrews, W.B. (Pacific National Lab., Richland, WA). *Nuclear Safety;* **27**: No. 4, 505-511(Oct-Dec 1986).

Pacific Northwest Laboratory conducted a study to evaluate alternatives to the design and operation of nuclear power plants, emphasizing a reduction of their vulnerability to sabotage. It used estimates of core melt frequency (CMF) during normal operations and from sabotage and tampering events to rank the alternatives. The CMF for normal operations was estimated by using sensitivity analysis of results from probabilistic risk assessments; for sabotage and tampering, by developing a model based on probabilistic risk analyses, historic data, and engineering judgment, and safeguards analyses of plant locations where core melt events could be initiated. Results indicate that the most effective alternatives focus on wide areas of the plant, increase safety system redundancy, and reduce reliance on single locations for mitigation of transients. Less effective options focus on specific areas of the plant, reduce reliance on some plant areas for safe shutdown, or focus on less vulnerable targets.

20442 **Assessment of extent and degree of thermal damage to polymeric materials in the Three Mile Island Unit 2 reactor building.** Alvares, N.J. (Lawrence Livermore National Lab.). pp 647-656 of Fire safety science. Grant, C.E.; Pagni, P.J. New York, NY; Hemisphere Publishing (1986). (CONF-851098—). Contract W-7405-ENG-48;AC07-76ID01570.

From International fire safety meeting; Gaithersburg, MD, USA (7 Oct 1985).

This paper describes assumptions and procedures used to perform thermal damage analysis caused by post loss-of-coolant-accident (LOCA) hydrogen deflagration at Three Mile Island Unit 2 Reactor. Examination of available photographic evidence yields data on the extent and range of thermal and burn damage. Thermal damage to susceptible material in accessible regions of the reactor building was distributed in non-uniform patterns. No clear explanation for non-uniformity was found in examined evidence, e.g., burned materials were adjacent to materials that appear similar but were not burned. Because these items were in proximity to vertical openings that extend the height of the reactor building, the authors assume the unburned materials preferentially absorbed water vapor during periods of high, local steam concentration. A control pendant from the polar crane located in the top of the reactor building sustained asymmetric burn damage of decreasing degree from top to bottom. Evidence suggests the polar-crane pendant side that experienced heaviest damage was exposed to intense radiant energy from a transient fire plume in the reactor containment volume. Simple hydrogen-fire-exposure tests and heat transfer calculations approximate the degree of damage found on inspected materials from the containment building and support for an estimated 8% pre-fire hydrogen.

20443 **TRAC-PF1/MOD1 computer code and developmental assessment.** Addessio, F.L.; Sahota, M.S.; Liles, D.R.; Mahaffy, J.H. (Los Alamos National Lab., NM). *Nuclear Safety;* **26**: No. 4, 438-454(Jul-Aug 1985).

The Transient Reactor Analysis Code (TRAC) is being developed at Los Alamos National Laboratory to provide advanced best-estimate predictions of postulated accidents in light-water reactors. The TRAC-PF1/MOD1 program provides this capability for pressurized-water reactors and for many thermal-hydraulic experimental facilities. The code features either one- or three-dimensional treatment of the pressure vessel and its associated internals; a two-phase, two-fluid, nonequilibrium hydrodynamics model with a noncondensable gas field; flow-regime-dependent constitutive equation treatment; optional reflood tracking capability for both bottom flood and falling-film quench fronts; and consistent treatment of entire accident sequences from normal operating conditions to severe transients. A new numerical algorithm is used in the one-dimensional hydrodynamics which permits this portion of the fluid dynamics to violate the material Courant condition. The technique permits large time steps and hence reduced running time for slow transients. Included in the article are the results of development assessment calculations performed with TRAC-PF1/MOD1 prior to its public release. The assessment set consists of six integral effects calculations in the Loss-of-Fluid Test and Semiscale facilities. Computer run times required to predict each test also are reported.

20444 **Safety system status monitoring.** Lewis, J.R. (Pacific Northwest Lab., Richland, WA). *Nuclear Safety;* **26**: No. 4, 459-467(Jul-Aug 1985).

Pacific Northwest Laboratory studied the safety aspects of monitoring the preoperational status of safety systems in nuclear power plants to assess the effectiveness of current monitoring systems and procedures, to develop acceptance criteria by which the adequacy of safety status monitoring systems can be evaluated, and to develop near-term guidelines for reducing human errors associated with monitoring safety system status. A review of safety system status monitoring practices indicated shortcomings with the current

systems and procedures used by control room operators. These shortcomings were even present in some systems and procedures installed to meet existing regulatory guidelines. Consequently this article suggests acceptance criteria for meeting the functional requirements of an adequate system for monitoring safety system status and near-term guidelines that could reduce the likelihood of human errors in specific, high-priority status monitoring tasks.

20445 **Technical note: the Federal Radiological Emergency Response Plan and the St. Lucie Exercise.** Gant, K.S.; Adler, M.V.; Wolff, W.F. (Oak Ridge National Lab., TN). *Nuclear Safety;* **26**: No. 4, 488-492(Jul-Aug 1985).

Utilities and state and local governments are required to plan their response for areas around a nuclear power plant that might be affected by an accident at the plant. Federal agencies that might assist in the emergency response have, in the past, operated under a series of statutory requirements, the 1961 Interagency Radiological Assistance Plan (IRAP), and memorandums of understanding. Although utilities and state and local governments can respond effectively, as judged by their plans and exercises, they have not worked with exercises of a full-scale federal response. The development, extensive testing during an actual power-plant exercise, revision, and subsequent publication of the new Federal Radiological Emergency Response Plan (FRERP) mark a significant advance in federal nuclear emergency preparedness. The plan addresses all types of peacetime radiological emergencies. These may include accidents at fixed nuclear facilities (including power reactors), transportation accidents, or other types of nuclear accidents, such as reentry of a nuclear-powered satellite. The FRERP was developed through an iterative process of review and preliminary exercises held to test the basic concepts of the plan and to identify the interactions between the agencies that are necessary for a coordinated response. Deficiencies in the plan that were pinpointed in the preliminary exercises were corrected. This exercise process culminated in nuclear disaster drills at Florida Power and Light Company's St. Lucie Power Plant in March 1984.

20446 **Experimental breeder reactor-II: 20 yr of operating experience.** Buschman, H.W. (Argonne National Lab., Idaho Falls, ID). *Nuclear Safety;* **26**: No. 4, 493-502(Jul-Aug 1985).

For 20 yr the Experimental Breeder Reactor-II (EBR-II), a liquid-metal fast breeder reactor power plant, has operated successfully. Comprised of a reactor building, sodium boiler building, and power plant, the EBR-II has operated as an integral power plant and fuel-cycle facility, as a fuels and materials irradiation facility, and as a component and systems test bed. Over 750 experimental subassemblies containing more than 11,000 individual fuel or structural specimens have been irradiated. Testing of new fuel concepts and LMFBR plant components is in progress, and testing of fuel response to off-normal conditions of breached cladding and mild overpower transients is well under way. Off-normal EBR-II testing includes plant loss-of-flow and loss-of-heat sink tests, and some without reactor scram demonstrate inherently safe characteristics of the EBR-II that can be extrapolated to other plant designs. A new program proposed by Argonne National Laboratory will utilize the EBR-II and other onsite facilities to demonstrate an integral breeder reactor-fuel recycle system.

# 25 ENERGY STORAGE

## 2509 Batteries

20447 **(LBL—22399) Kinetics and transport processes in aqueous polysulfide electrode reactions.** Lessner, P.M.; McLarnon, F.R.; Cairns, E.J. (Lawrence Berkeley Lab., CA (USA)). Sep 1986. Contract AC03-76SF00098. 250p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE87006247.

Fundamental and applied research on the aqueous sulfide/polysulfide redox couple has been carried out, motivated by its possible use in photoelectrochemical cells (PECs) and redox batteries. Recent work on PECs has concentrated on the reactions at photoelectrodes. Much less attention has been given to the development of efficient redox electrodes which can be used as a counterelectrode in a PEC or as an electrode in a redox cell. Objectives of the present work are to obtain information on the electrochemical and chemical reactions of the aqueous sulfide/polysulfide redox couple and to use that information to design a stable and efficient redox electrode.

20448 **(SAND—87-7061) Design and development of a multi-kilowatt hour hydrogen/nickel oxide battery.** Dunlop, J.; Earl, M.; Brown, M.; Vaidyanathan, H.; Gentry, W.; Beauchamp, R.; Sindorf, J. (Communications Satellite Corp., Clarksburg, MD (USA). COMSAT Labs.; Johnson Controls, Inc., Milwaukee, WI (USA); Sandia National Labs., Albuquerque, NM (USA)). Jan 1987. Contract AC04-76DP00789. 124p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87006774.

Work continued to develop a sealed, hydrogen/nickel oxide battery for deep discharge, 20-year life, terrestrial energy storage applications that would be cost-competitive with lead-acid batteries. The latest battery delivered to Sandia has five individual prismatic cells in a common pressure vessel; the cells are connected in series resulting in a nominal six volts. Thicker positive electrodes developed during the contract increased the capacity of the cells from about 100 Ah to 145 Ah.

# 29 ENERGY PLANNING AND POLICY

## 2901 Energy Analysis And Modeling

20449 **(DOE/OR/00033—T258) A plausible future of rapid energy growth in China.** Jovanovich, J.V.; Rotty, R.M. (Oak Ridge Associated Universities, Inc., TN (USA); Manitoba Univ., Winnipeg (Canada). Dept. of Physics). 16 Jan 1987. Contract AC05-76OR00033. 36p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87004876.

The future energy consumption of China is investigated through the use of historical analogies. It is argued that future energy growth in China much larger than was estimated in most previous studies is quite plausible. The implications of this result are of great importance when constructing scenarios for the anticipated future fossil-fuel consumption and a corresponding increase of atmospheric carbon dioxide. This result reaffirms the desirability of world-wide growth of nonfossil energy systems.

## 2902 Economics And Sociology

*REFER ALSO TO CITATION(S) 20166, 20167, 20308, 20463, 20475*

## 2903 Environment, Health, And Safety

*REFER ALSO TO CITATION(S) 19925, 20045, 20062, 20063, 20064, 20065, 20066, 20067, 20068, 20069, 20070, 20071, 20072, 20073, 20074, 21069, 21086, 21087, 21109, 21110, 21111, 21113, 21117, 21118, 21138, 21139, 21236, 21237*

20450 **(AD-A—175274/0/XAB) Health and environmental effects data base assessment of US Army waste material. Final report, 4 April 1984-4 March 1986 on Phase 2.** Uhrmacher, J.C.; Werschulz, P.P.; Schultz, D.O.; Weber, D.O. (Carltech Associates, Columbia, MD (USA)). 4 Mar 1986. 453p. (CARLTECH—8447). NTIS, PC A20/MF A01.

See also Phase 1, AD-A173 884.

Substances used by the U.S. Army on a regular basis in accomplishing their missions of training, defense, and weapons development have a wide range of uses, storage, and disposal methods. Humans and the environment may be exposed to them in varying amounts. Proper research planning requires knowledge of gaps in health and environmental data on those compounds. CARLTECH was contracted to develop a data base on health and environmental effects of waste materials generated by the U.S. Army. The project was divided into two phases: Phase I which consisted of identification of Army-unique materials for inclusion in the data base. Phase II which consisted of researching, aggregating and reporting data on physical, chemical, health and environmental properties of the substances. This report covers Phase II efforts. Sixty-one substances were studied during Phase II of this project. Data on chemical and

physical properties, Army and other uses, analytical methods, health effects, environmental effects, standards and regulations, and disposal methods were obtained on each substance researched. Results of this project with respect to data gaps are presented below. Physical and chemical data; analytical methods; and health effects areas had the better data coverage. Twenty substances had insufficient direct health effects data and were characterized using structural analogues. Additional research is required for these 20 substances.

20451 **(DOE/OR/00033—T256) The $CO_2$ future: Inevitability or choice?.** Sigmon, E.B. (Oak Ridge Associated Universities, Inc., TN (USA)). Sep 1986. Contract AC05-76OR00033. 36p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87004881.

The study discusses emissions of carbon dioxide and influences on future emissions levels. The forces that will determine future $CO_2$ emissions are categorized into two broad evolutionary processes, economic growth and technological progress. The central question in predicting the future trajectory of $CO_2$ emissions is the balance between these competing forces. How various pressures push development and progress in $CO_2$-reducing directions is identified. (ACR)

20452 **(PB—87-114351/XAB) Waste-minimization issues and options. Volume 1. Report to Congress (Final).** (Versar, Inc., Springfield, VA (USA)). Oct 1986. 402p. NTIS, PC A18/MF A01.

See also PB—87-114344 and PB—87-114369; Also available in set of 5 reports PC E99, PB—87-114328.

The report has three primary objectives: (1) to identify waste minimization practices in the United States by major industry processes and by major waste stream; (2) to identify factors that promote and inhibit the adoption of waste-minimization practices by industry; and (3) to identify strategies by which waste minimization can be increased. The report also serves as a resource document on waste minimization for Federal and State programs industries, and the general public. It must be noted that this study approval has the objectives stated above in an exploratory manner because of the size, diversity, and complexity of the subject.

20453 **(PB—87-114377/XAB) Waste-minimization issues and options. Volume 3. Report to Congress (Final).** (Versar, Inc., Springfield, VA (USA)). Oct 1986. 278p. NTIS, PC A13/MF A01.

See also PB—87-114369; Also available in set of 5 reports PC E99, PB—87-114328.

The report is a supplement to Waste Minimization - Issues and Options Volume I. It contains the following information: (1) Recycling technologies and practices; (2) A description of the Northeast Industrial Waste Exchange's on-line computer system; (3) Conducting a project profitability analysis; (4) EPA's definition of Solid Waste; (5) EPA correspondence on Waste Minimization activities; (6) Compilation of industrial waste-reduction cases; (7) EPA's environmental auditing policy statement; (9) Descriptions of State programs; and (10) Two proposed regulations on hazardous-waste management by two counties in California.

20454 **(PB—87-129409/XAB) Preliminary evaluations of initial TSCA (Toxic Substances Control Act) Section 8(E) substantial risk notices. January 1, 1983 to December 31, 1984.** (Environmental Protection Agency, Washington, DC (USA). Office of Pesticides and Toxic Substances). Mar 1985. 335p. (EPA—560/2-85/001). NTIS, PC A15/MF A01.

See also PB—83-187815.

The volume contains, in ascending submission number order, status report (i.e., preliminary evaluations) prepared by staff of the Office of Toxic Substances in EPA's Office of Pesticides and Toxic Substances for initial submissions received by EPA from chemical manufacturers, importers, processors, and distributors from January 1, 1983 to December 31, 1984 under Section 8(e), the substantial risk information reporting provision of the Toxic Substances Control Act (TSCA). The status reports contained in this compendium reflect only the initial phases of EPA's evaluation process for the submitted information.

20455 **(PB—87-129821/XAB) Technical resource document: treatment technologies for solvent contaminants.** (GCA Corp., Bedford, MA (USA). GCA Technology Div.). Oct 1986. 799p. NTIS, PC A99/MF A01.

The report provides information that can be used by environmental regulatory agencies and others as a source of technical information describing waste-management options for solvents and other wastes containing low-molecular-weight organic compounds. These options include waste minimization (i.e., source reduction, reuse, recycling), treatment, and disposal of waste streams. Although emphasis is placed on the collection and interpretation of performance data for proven technologies, the full range of waste-minimization processes and treatment/recovery technologies that can be used to manage solvent wastes is discussed.

## 2904 Natural Resources

*REFER ALSO TO CITATION(S) 21248, 21249, 21250, 21251, 21252, 21253, 21254, 21262*

20456 **(PB—87-133724/XAB) Tropical forests: a call for action. Part 1: the plan. Part 2: case studies. Part 3: country investment profiles.** (World Resources Inst., Washington, DC (USA)). Oct 1985. 147p. NTIS, PC PC E06/MF E01.

Library of Congress catalog card no. 85-51864.

The World Resources Institute (WRI), in cooperation with multi- and bi-lateral organizations, has launched a major initiative to conserve forests in the humid and semiarid/arid areas of developing countries. The 3-part WRI report is a call to political action on this subject. Part 1 describes the high costs exacted by deforestation, but asserts that the process can be arrested and reversed by a partnership of governments, local participants, and development-assistance agencies. Proposals are presented for a 5-year action plan in farm, community, and arid-zone forestry. Parts 2 and 3 include case studies of the successful projects listed in Part 1 and 5-year investment profiles of 56 developing countries affected by deforestation.

20457 **Dependence on mineral resources.** Rapp, J.S. *California Geology;* 37: No. 9, 188-192(Sep 1984).

Mineral products provide food, shelter, and income. The price and availability of these mineral commodities has a tremendous influence on national productivity and on their standard of living. With increased competition of various land uses, housing, agriculture, industry, mining, recreation, and wilderness preservation, many important decisions are being made by government officials with respect to mineral resource management and development. This paper briefly reviews the importance and uses of common mineral products of California.

## 2905 Research, Development, Demonstration, And Commercialization

*REFER ALSO TO CITATION(S) 19893, 19894, 19895, 19922, 19929, 19930, 19934, 19935, 19936, 19937, 19940, 19941, 19942, 19948, 19952, 19953, 19954, 19955, 19996, 20019, 20530, 20924, 20925, 20926, 20927*

## 2906 Nuclear Energy

*REFER ALSO TO CITATION(S) 20045, 20061, 20062, 20063, 20064, 20065, 20066, 20067, 20068, 20069, 20070, 20071, 20072, 20073, 20074*

20458 **(INIS-mf—10570, pp 7-18) Power engineering and the environment.** Maurer, A. 1985. (In Czech). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701462. (CONF-8505340—Exc.).

From Prediction of environmental impact of power generation conference; Bratislava, Czechoslovakia (23 May 1985).

The planned contribution is given of nuclear power plants to power production in the years 1985, 1990 and 2000. The advantages are given of nuclear power plants and the environmental impacts are discussed of their construction and operation. (E.S.).

**20459 (Juel-Spez—358) Consequences of a withdrawal from the use of nuclear energy.** Wagner, H.J.; Bundschuh, V.; Duering, K.; Martinsen, D.; Riemer, H.; Walbeck, M. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Programmgruppe Systemforschung und Technologische Entwicklung). Jun 1986. 102p. (In German). NTIS (US Sales Only), PC A06/MF A01. File Number DE87750824.

Aktuelle Beitraege zur Energiediskussion. No. 12.

First the consequences of an immediate withdrawal are considered, i.e. a replacement of electricity generation capacity can not be built up in time. Then assumptions and results for a withdrawal in stages are presented. This means, that a replacement of nuclear generation capacity is possible. The applied energy model allows statements about the future structure of energy supply, the mass balances, the costs, and the SO/sub 2/, NO/sub x/ and CO/sub 2/ emissions from increased coal combustion.

## 2908 Waste Heat Utilization

*REFER ALSO TO CITATION(S) 20509*

## 2910 Conservation

*REFER ALSO TO CITATION(S) 20497, 20498, 20506*

**20460 (EEO-ED—81) Assessment of 'replication'.** Gammon, R.B. (Department of Energy, London (UK). Energy Efficiency Office; UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.). Jun 1986. 50p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751354.

The Energy Efficiency Demonstration Scheme, a government-funded programme which began in 1978, has to be able to demonstrate its cost-effectiveness and, to this end, the Energy Efficiency Office has approved targets which must be achieved by certain dates. An impartial assessment is given of the December 1985 Target which is expressed in terms of the energy savings achieved by firms 'replicating' the technologies demonstrated under the Scheme. It is shown that the value of the energy savings is about Pound 130M/year and hence the Scheme seems well on course to achieving its 5:1 objective.

**20461 (NP—7751615) ASSE demonstration program - conserving energy with technical systems for separate homes with common facilities shared by a maximum of users. Final report.** Georgieff, P.; Morovic, T.; Overkott, S.; Schaefer, G.F. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Karlsruhe (Germany, F.R.). Inst. fuer Systemtechnik und Innovationsforschung). Sep 1981. 93p. (In German). NTIS (US Sales Only), PC A05/MF A01. File Number DE87751615.

This preparatory study aimed at assessing the actually given socio-economic conditions which apart from the town construction, architectonic and technical factors decide on the suitability of Wittmar as a demonstration site. The chapter under review is therefore centering on the following questions: Are the regional and local developments compatible with the demonstration program. Will the regional and local infrastructure stand the influx of those wishing to settle in the Wittmar region. Will it suffice to integrate the growing population into the community. The analysis of the regional or local socio-economic structure is based on different statistical data, local and regional developing schemes and investigations carried out by the team itself (telephone interviews, site inspection). The team was trying to analyse and compare the developing potential of the community to the regional development and to assess the advantages and disadvantages of the prospective site with particular regard to the regional conditions and context.

**20462 (PB—87-131371/XAB) Africa Bureau energy-strategy statement, Agency for International Development.** (Agency for International Development, Washington, DC (USA)). Jan 1985. 54p. NTIS, PC A04/MF A01.

The Bureau for Africa Energy Strategy Statement focuses on identifying the energy constraints to economic development as well as potential pportunities for utilizing energy more effectively in Mission agriculture and rural development projects. A direct correlation exists between energy and national levels of economic development. Over the next twenty years, large increases in energy will be required to achieve desired development objectives in Africa. Increasing energy inputs to the agricultural sector appear to produce major increases in productivity, in some cases exceeding the beneficial impacts of increasing energy inputs to industry by a factor of ten.

**20463 (PB—87-131546/XAB) Innovative approaches to financing energy-conservation investments in developing countries. Technical report.** (Hagler, Bailly and Co., Washington, DC (USA)). 10 Sep 1984. 39p. (RA—84-158-3). NTIS, PC A03/MF A01.

Contents include: Innovative financing methods for energy conservation (Shared savings, Arrangement structure, Example of a shared-savings financing arrangement, Joint-venture arrangement between an energy user and an external investor, Arrangement structure, Example of a joint venture, Energy service agreement, Arrangement structure, Example of an energy service agreement); Variable-payment loan (Arrangement structure, Example of a variable-payment loan, Limited-term, guaranteed-payback loan, Arrangement structure, Example of a limited-term, Guaranteed-payback loan); Potential roles for the public sector.

**20464 (PB—87-132916/XAB) Conclusions and recommendations of the Latin America and Caribbean Regional Energy Conservation Seminar, Alajuela, Costa Rica, January 14-17, 1985.** (Hagler, Bailly and Co., Washington, DC (USA)). 29 Mar 1985. 62p. (HBC—85-162). NTIS, PC PC E04/MF E01.

Reports were given on active energy-conservation projects in the region (Barbados, Jamaica, Central American region and Panama, Peru, Ecuador, the Dominican Republic, and Costa Rica). In addition, there were presentations on energy auditing, fuel substitution, and financing energy conservation. Although the seminar concentrated on the industrial sector, it also explored opportunities for energy-efficiency improvements in the building and transportation sectors.

## 2920 Supply, Demand, And Forecasting

*REFER ALSO TO CITATION(S) 19979, 19993, 20166, 20462, 20467*

## 2930 Policy, Legislation, And Regulation

*REFER ALSO TO CITATION(S) 19995, 20167*

**20465 (EIU-SR—231) Soviet energy to 2000.** Wilson, D. (Economist Intelligence Unit, London (UK)). 1986. 231p. British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

The report presented covers the Soviet long term energy programme, available energy, and oil and gas exploration and production. Oil pipelines and pipeline technology, oil refining, energy consumption, electricity, the coal industry and energy trade are reviewed.

**20466 (NP—7751611) France - energy situation 1985.** (Bundesstelle fuer Aussenhandelsinformation, Koeln (Germany, F.R.)). Nov 1986. 28p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751611.

The energy situation of France is reviewed on the basis of relevant data. Data on the country's national and international energy policy are followed by an outline of trends in energy sources and electric power generation. Key figures are presented on the country's external trade and balance of payments.

**20467 (NP—7751612) Ecuador - energy situation 1985/1986.** (Bundesstelle fuer Aussenhandelsinformation, Koeln (Germany, F.R.)). Nov 1986. 26p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751612.

The energy situation of Ecuador is reviewed on the basis of relevant data. Data on the country's national and international energy policy are followed by an outline of trends in energy sources and electric power generation. Key figures are presented on the country's external trade and balance of payments.

20468 **(NP—7751613) Ghana - energy situation 1985/1986.** (Bundesstelle fuer Aussenhandelsinformation, Koeln (Germany, F.R.)). Nov 1986. 18p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751613.

The energy situation of Ghana is reviewed on the basis of relevant data. Data on the country's national energy policy are followed by an outline of trends in energy sources and electric power generation. Key figures are presented on the country's external trade and balance of payments.

20469 **(NP—7751614) Tanzania - energy situation 1985/1986.** (Bundesstelle fuer Aussenhandelsinformation, Koeln (Germany, F.R.)). Nov 1986. 17p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751614.

The energy situation of Tanzania is reviewed on the basis of relevant data. Data on the country's national and international energy policy are followed by an outline of trends in energy sources and electric power generation. Key figures are presented on the country's external trade and balance of payments. Bilateral cooperation projects are mentioned.

## 2940 Fossil Fuels

*REFER ALSO TO CITATION(S) 19893, 19894, 19895, 19922, 19925, 19929, 19930, 19934, 19935, 19936, 19937, 19940, 19941, 19942, 19948, 19952, 19953, 19954, 19955, 19978, 19979, 19980, 19981, 19982, 19983, 19993, 19995, 19996, 20019, 20465*

20470 **(DOE/EIA—M018) Software documentation and user's guide for the well completion estimation procedure.** (USDOE Energy Information Administration, Washington, DC. Office of Oil and Gas). Mar 1987. 90p. NTIS MF A01-GPO; 2; GPO Dep. File Number DE87006754.

This report constitutes a complete description of the software used in the data processing system of the Well Completion Estimation (WELCOM) model. WELCOM updates monthly the drilling data compiled by the American Petroleum Institute in Washington, DC, as received from various state agencies. This report provides a complete description of the WELCOM model and also allows the user to understand the detail of the methodology developed in the WELCOM software. For each WELCOM program, the purpose, input, output and method used are described. The data set files needed in the WELCOM data processing system are given. The User's Guide allows the user to monthly update the WELCOM data set files and the published MER drilling tables by calling five different MACROS from SUPERWYLBUR. These MACROS generate JCL streams and also submit the JOBS for batch execution.

## 2950 Hydrogen And Synthetic Fuels

*REFER ALSO TO CITATION(S) 20167*

## 2960 Electric Power

*REFER ALSO TO CITATION(S) 19942, 20319, 20465*

20471 **(DOE/EIA—0437(85)) Financial statistics of selected electric utilities, 1985.** (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). 27 Feb 1987. 937p. NTIS, PC A99/MF A01 - GPO; 1; GPO Dep. File Number DE87006836.

The Financial Statistics of Selected Electric Utilities provides information about electric utility accounting and operations in a concise format to satisfy the needs of electric utilities, industry, educational institutions, and government. For the private sector, the information has been taken from the annual report of major private electric utilities provided to the Energy Information Administration for the calendar year 1985. For the public sector, information from 162 public electric utilities that have continuously submitted data to the Energy Information Administration are provided in this publication for 1985. The uniformity of treatment accorded the utilities' statements in this report will generally permit ready comparison of items among the utilities included in the compilations.

20472 **(EPRI-EM—5062-SR) Demand-side planning program: Projects and products, 1974-1986.** Ried, D. (Nesbit (William) and Associates, Santa Rosa, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 87p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920291.

EPRI, through the Demand-Side Planning (DSP) Program, develops tools, data, and methods to help electric utilities predict energy use, plan how best to meet consumption requirements, and influence electricity use to provide greatest benefits to both customers and utilities. This report provides the first comprehensive listing of DSP Program projects and products.

20473 **(EPRI-EM—5068) Cost-benefit analysis of demand-side planning alternatives: Final report.** Barrager, S.M.; Buckley, O.E. (Decision Focus, Inc., Los Altos, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 145p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920288.

Choosing demand-side programs that are cost-effective for both utilities and their customers is the fundamental concern of demand-side planners. To assist utility decision making in this area, this report outlines a six-step procedure for cost-benefit analysis of demand-side options.

20474 **(EPRI-EM—5093) Survey of utility lighting programs: Final report.** Isaksen, L. (Analysis and Control of Energy Systems, Inc., Martinez, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 79p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920290.

Reshaping loads is a major goal of utility lighting efforts. Nearly 60% of the utilities in this survey use lighting for demand-side management. The most popular programs promote lighting efficiency to reduce daytime peaks and outdoor security lighting to increase off-peak loads.

20475 **(PB—87-132338/XAB) Catalogue of rural electric-utility and small-hydropower training programs.** (National Rural Electric Cooperative Association, Washington, DC (USA)). 1984. 38p. NTIS, PC A03/MF A01.

Rural electric-utility and small-hydropower training programs offered by the National Rural Electric Cooperative Association (NRECA) are described in the catalogue. Described are courses in NRECA's growing, but still small, U.S.-based program and in its extensive overseas program. Included in the latter are courses in basic and advanced management for rural electric utilities, covering management skills, accounting, engineering, construction, technical skills, front-line supervision, and operations and maintenance. Also described are 15 courses in small hydropower technology and specialized courses in wood-pole preservation and maintenance. Overseas courses generally last 3-5 days (although the length of the specialized courses is not specified), while U.S.-based courses last 10 days to 6 weeks. A list of 36 course instructors is provided.

20476 **(PNL—6181) Irrigation customer survey procedures and results.** Harrer, B.J.; Johnston, J.W.; Dase, J.E.; Hattrup, M.P.; Reed, G. (Pacific Northwest Lab., Richland, WA (USA)). Mar 1987. Contract AC06-76RL01830. 74p. NTIS MF A01; 2; GPO Dep. File Number DE87006809.

This report describes the statistical procedures, administrative procedures, and results of a telephone survey designed to collect primary data from individuals in the Pacific Northwest region who use electricity in irrigating agricultural crops. The project was intended to collect data useful for a variety of purposes, including conservation planning, load forecasting, and rate design.

### 2980 Consumption And Utilization

*REFER ALSO TO CITATION(S) 19982, 19983, 20465*

20477 **(NP—7751621) Data on the development of the West German energy industry in 1985.** (Bundesministerium fuer Wirtschaft, Bonn (Germany, F.R.)). Jul 1986. 66p. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE87751621.

An introducing survey of international and national energy policies in 1985 as well as of the energy supply situation in the Federal Republic of Germany is followed by statistics, tables and diagrams containing significant data of energy economics. In particular, they refer to the primary energy balance, structure of energy consumption, import and export of energy supplies and the development on the hard coal, brown coal, mineral oil, electricity and gas market (reserves, application, prices). The year under review, 1985, is related to and compared with previous years reaching back as far as 1970.

### 2990 Unconventional Sources And Power Generation

*REFER ALSO TO CITATION(S) 20260, 20267, 20297, 20308*

20478 **(BREF-P—0685) Scope for renewable energy in the UK.** (British Renewable Energy Forum, London). Jun 1985. 46p. British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. Price Pound 3.00.

A report is given on the contribution now made, and which could in the foreseeable future be made, by renewable energy technologies into the overall energy supply and demand context of the UK. Four immediate actions are proposed by the British Renewable Energy Forum to encourage the use of renewables.

20479 (UK-ISES—C40, pp 44-49) **Community solar energy demonstration projects: success or failure.** Joels, R.K. 11 Apr 1985. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ. (CONF-8504294—).

From Workshop on solar energy and building design; Birmingham, UK (11 Apr 1985).

At the present time the European Commission is discussing, in the forum of the Council of Ministers, its proposal for a new five year demonstration programme. The results of the last six years in solar energy is assessed and a preview of the strategy the Commission hopes to follow is given.

## 30 DIRECT ENERGY CONVERSION

### 3001 Mhd Generators

20480 **Slagging coal combustors for MHD applications.** Bauer, M.; Braswell, R.; Iwata, H. (TRW Space and Technology Group, Applied Technology Div., One Space Park, Redondo Beach, CA). pp 910-922 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—).

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

This paper presents an overview of the MHD slagging combustor development status at TRW including the 11 year total development process and the 8 1/2 years of development while under contract to the DOE. The general design features of the high pressure MHD slagging coal-fired combustor approach is presented together with the specific features of the 10, 20 and 50 MW/sub t/ MHD two stage coal combustors. The results of each of the combustor development programs has been summarized and the specific slag recovery, heat loss and carbon conversion results are presented. At the 20 MW/sub t/ combustor level, the feasibility of operating the combustor at state-of-the-art air preheat levels (900-1500°F) was investigated. These results are compared to the high air preheat (2900°F) tests conducted with the same 20 MW/sub t/ combustor. With the benefit of these test results, a low air preheat modification to the 50 MW/sub t/ combustor was designed with fabrication and testing scheduled to start in 1986. Both the 20 and 50 MW/sub t/ coal-fired combustors were tested as part of MHD topping cycle test power trains. The 20 MW/sub t/ combustor was tested with the AVCO designed MK VI channel at the AVCO Everett MHD test facility located near Boston.

### 3005 Fuel Cells

*REFER ALSO TO CITATION(S) 20509*

20481 **Surfactant addition to phosphoric acid electrolyte.** Jackovitz, J.F.; Kunkle, R.P. (to Dept. of Energy, Washington, DC). US Patent 4,639,401. 27 Jan 1987. Filed date 26 Feb 1986. vp.

This patent describes a fuel cell comprising a container having disposed therein: a cathode, an anode, a divider positioned between the cathode and anode to separate the cathode and anode one from the other. The container also has an electrolyte comprising H/sub 3/PO/sub 4/ and at least about 0.5 wt. percent of an amine capable of reacting with the H/sub 3/PO/sub 4/ in situ to produce an ammonium phosphate thereby reducing interfacial tension and increasing the wetting properties of the H/sub 3/PO/sub 4/.

20482 **Materials for high-temperature fuel cells.** Ackerman, J.P.; Claar, T.D. (Argonne National Lab., Argonne, IL 60439). *Journal of Materials for Energy Systems;* 8: No. 3, 284-290(Dec 1986).

The design and operation of advanced high-temperature fuel cells are described. The functional requirements of the various cell components are reviewed, and the basis of selection of cell materials and fabrication processes is presented. The possible directions that fuel cell materials research and development will take during the next 20 years are discussed.

## 32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

### 3201 Buildings

*REFER ALSO TO CITATION(S) 20271, 20460, 20461*

20483 **(CONF-870416—4) International developments in heat pump technology.** Creswick, F.A. (Oak Ridge National Lab., TN (USA)). Jan 1987. Contract AC05-84OR21400. 18p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87006206.

From 14. annual energy technology conference and exposition; Washington, DC, USA (14 Apr 1987).

The thesis of this presentation is that heat pump technology is at present well diffused throughout Western Europe, Japan, and North America, but differences in climate, fuel availability and pricing, and conventional heating, ventilating, and air conditioning (HVAC) practice have resulted in uniquely different products in each region. Moreover, present differences in the heat pump market situation are affecting the directions and vigor of future R and D efforts in each region.

20484 **(DOE/BP/15102—1) Carbon-dioxide-based ventilation control system demonstration: Final report.** Gabel, S.D.; Janssen, J.E.; Christoffel, J.O.; Scarborough, S.E. (Honeywell, Inc., Golden Valley, MN (USA). Technology Strategy Center). Apr 1986. Contract AC79-84BP15102. 164p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE87006020.

Commercial buildings require mechanical ventilating systems, the specifications for which are included in the building codes. These codes specify the amount of outdoor air to be supplied per person for designed occupancy conditions. Many buildings such as retail establishments operate much of the time at occupancy loads well below the design. Thus, they are generally over-

ventilated and waste energy when operated according to the codes. A control system based on measurement of the carbon dioxide generated by the occupants was tested in a small bank in Pasco, Washington. Energy consumption, indoor air contaminant levels and occupant response were measured. Average energy savings of 7.8% over the code-specified ventilating rate were found to be possible for the Washington/Oregon area. Buildings similar to the one tested but located in six different cities in the Pacific Northwest showed savings that range from 2492 kWh in Astoria, Oregon, to 6563 kWh in Spokane, Washington. A payback period of 2 to 3 years for a $CO_2$ control system appears possible for the colder climates east of the Cascade Mountains. Nitrogen dioxide, formaldehyde, carbon monoxide and particulate levels were well below recommended limits. Measurement of subjective response showed that the occupants could not detect a difference between the background level of 300 ppM of $CO_2$ and a level of 1000 ppM. An electric heating system was used that had marginal steady-state capacity. It was found that the supply air fan speed should be reduced when heating the building to avoid uncomfortable drafts.

20485 **(EEO-ED—82-101) Advanced lighting control system using mains signalling and remote (infra-red) reset in a refurbished office building. A demonstration at Lloyds Bank plc. Final Report.** (Department of Energy, London (UK). Energy Efficiency Office; Building Research Establishment, Watford (UK); London School of Economics and Political Science (UK). Dept. of Social Psychology). Jun 1986. 34p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751358.

Lloyds Bank has installed an automatic lighting control system, manufactured by Home Automation Ltd., at Black Horse House, a 15-storey office building located in central London. The resulting reduction in lighting energy consumption was 129,030 kWh/year and this corresponded to a monetary saving of Pound 6,450. Lloyds selected a system which uses mains signalling and infra-red switching because this minimises control wiring and thus permits maximum flexibility in office layout. The control system provides central off-switching (time-based), localised manual switching and photo-electric control. Energy and cost savings have resulted from reduced use of artificial lighting after each automatic switch-off and from matching the local lighting environment to user requirements.

20486 **(EEO-ED—85-172) Ventilation control by measurement of carbon dioxide levels in public entertainment buildings. A demonstration in a cinema and a bingo and social club operated by Rank Organisation plc. Final Report.** (Department of Energy, London (UK). Energy Efficiency Office; ECD Partnership, London (UK)). Jul 1986. 28p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751357.

To determine the fuel cost savings that would result from reducing ventilation rates during periods of low occupancy, the Rank Organisation retrofitted a variable fresh air ventilation system, controlled by a carbon dioxide ($C0_2$) detector, at a social club and cinema. The detector is linked to dampers which adjust the flow of fresh air into the building to maintain $C0_2$ levels within limits set to provide an acceptable internal environment. Conversion to $C0_2$-controlled ventilation included three main components; an air temperature controller; a variable fresh air ventilation system and a $CO_2$ detector. Operational experience, the monitoring program, measured results, energy savings and economic analyses are discussed.

20487 **(NP—7900317) Study of working fluid mixtures and high temperature working fluids for compressor driven systems: Final report, Part B.** Berntsson, T.; Schnitzer, H. (Chalmers Univ. of Tech., Goeteborg (Sweden); Technische Univ., Graz (Austria)). Sep 1986. 159p. NTIS (US Sales Only), PC A08/MF A01. File Number DE87900317.

The objectives of this study are to gather theoretical and experimental information for heat pump systems operating with new working fluids or mixtures with special emphasis on nonazeotropic mixtures, and to evaluate their potential in comparison with other heat pump systems.

20488 **(PB—87-133575/XAB) MAX air-conditioner development: advanced indirect/direct evaporative cooling. Final report, 5 December 1984-31 July 1986.** Bacchus, R.; Dowdy, J. (Bacchus Industries, Inc., Sunland Park, NM (USA)). Nov 1986. 80p. NTIS, PC A05/MF A01.

The project developed and tested advanced evaporative cooling systems. Analysis of psychrometric information and test results are included. Indirect performance factors (PF) of 1.10+ were obtained on supply air systems (no return). Total PF's of over 1.50 and temperature drops of 55°F were obtained for indirect/direct evaporative-cooling supply systems at 1% El Paso design conditions (100 dry bulb/64 wet bulb ambient 45 dry bulb supply with no return). A computer design model was developed and applications are indicated for evaporative cooling, refrigeration combination, desiccant cooling combination, and cooling towers.

20489 **Heat distribution by natural convection.** Balcomb, J.D. (Los Alamos National Lab., Los Alamos, NM 87545). pp 277-281 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

Natural convection can provide adequate heat distribution in many situations that arise in buildings. This is appropriate, for example, in passive solar buildings where some rooms tend to be more strongly solar heated than others. Natural convection can also be used to reduce the number of auxiliary heating units required in a building. Natural airflow and heat transport through doorways and other internal building apertures is predictable and can be accounted for in the design. The nature of natural convection is described, and a design chart is presented appropriate to a simple, single-doorway situation. Experimental results are summarized based on the monitoring of 15 passive solar buildings which employ a wide variety of geometrical configurations including natural convective loops.

20490 **The measured energy performance of many, many buildings.** Meier, A.K. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). pp 91-103 of Proceedings of the third annual Nevada energy forum and exposition. Carson City, NV; Governors Office of Community Services (1984). (CONF-841144—). Contract AC03-76SF00098.

From 3. annual Nevada Energy Forum conference; Reno, NV, USA (19 Nov 1984).

This paper describes several compilations of measured energy performance of buildings and equipment. These compilations cover new, low-energy residential buildings, residential retrofits, new commercial buildings, and commercial retrofits. The databases contain measured energy consumption from over a thousand studies, consisting of about 50,000 buildings. The principal goals of the compilations are to develop techniques for characterizing measured building energy performance and identifying successful, cost-effective conservation and solar strategies. Some results of the compilation of new, low-energy homes are presented.

20491 **Investigation of factors influencing infrared roof moisture surveys using a mathematical model.** Childs, K.W.; Courville, G.E.; Childs, P.W. (Union Carbide Corp., Oak Ridge, TN). *Proceedings of the Society of Photo-Optical Instrumentation Engineers;* **446**: 82-94(1984). Contract W-7405-ENG-26.

From International conference on thermal infrared sensing for diagnostics and control (Thermosense VI); Bellingham, WA, USA (1984).

In low sloped roofing systems using porous insulation, the presence of water can significantly degrade thermal performance. Because of the different thermal characteristics of wet and dry insulation, there is often a surface temperature differential between areas of wet and dry insulation. Under the right circumstances, the areas of wet insulation can be detected by means of infrared sensing techniques. To better define the conditions under which infrared techniques can distinguish between areas of wet and dry insulation, a mathematical model was developed. This model is a one-dimensional, transient heat transfer model of a roofing system. The model

considers conduction through the roof, insulation, radiant exchange between roof and sky, convective heat transfer between the roof and air, and the influence of moisture trapped in insulation. For one particular roof system, a parametric study was undertaken using this model to determine the influence of moisture content, outside air temperature, wind speed, insulation, sky temperature, and other factors on the roof surface temperature. Preliminary recommendations for employing thermal sensing techniques to locate wet insulation are developed. 11 references, 12 figures.

## 3202 Transportation

*REFER ALSO TO CITATION(S) 20460, 20603*

**20492 (AD-A—175590/9/XAB) Structure of $SiO_2$-sol-gel glasses produced from gels with various mole-water per mole-TEOS ratios.** Kordas, G. (Vanderbilt Univ., Nashville, TN (USA). Dept. of Mechanical and Materials Engineering). 1985. 6p. NTIS, PC A02/MF A01.

Published in Materials Research Society Symposium Proceedings, Vol. 61, 419-423.

$SiO_2$ gels produced with 4, 8, and 16 mol water per mol TEOS were densified up to 1000 C and then exposed to gamma-ray irradiation in order to produce paramagnetic defect centers. Various paramagnetic states were detected during densification of these gels, the formation of which depends on the mol water per mol TEOS ratio. In the gels, $O_2$(-) ions were detected. The paramagnetic centers detected in the n = 16 gel with T/sub H/ = 900 C were attributed to a non-bridging oxygen and an $E'_1$-center. Three different $O_2$(-) ions, probably in interstitial positions, were detected in the n = 16 gel with T/sub H/ = 1000 C. The $CO_2$(-) center was observed in the n = 8 gel with T/sub H/ = 900 C. A variety of new components occur at T sub H = 1000 C in the N = 8 gel, the origin of which remains unresolved at present. The $CH_3$ $CO_2$(-), and $E'_1$-centers were detected in the n = 4 gel with T sub H = 700 C. The $CO_2$(-), and $E'_1$-centers were preserved after heat treating the n = 4 gel at T/sub H/ = 1000 C.

**20493 (NP—7770068) Microscopic simulation of energy consumption and exhaust gas emission in road traffic.** Benz, T. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Bauingenieur- und Vermessungswesen). 18 Dec 1984. 127p. (In German). NTIS (US Sales Only), PC A07/MF A01. File Number DE87770068.

A simulation model was set up in order to fully account for chain of effects of: road traffic measures, driver behaviour, vehicle, energy consumption, exhaust gas emission and traffic flow. Detailed description is given of the microscope simulation of the traffic flow, the determination of energy consumption and exhaust gas emission (basics of driving dynamics, engine parameters), and details of the model (program structure, various vehicle types, gearshift behaviour, computing and print-outs). The model was then applied to a simple case of different coordination systems for traffic signals to road sections in residential quarters with a speed limit of 30 km/h resp. 50 km/h and to motorway conditions. The influence of traffic signal coordination on energy consumption and exhaust gas emission was determined. The model is then compared to other methods (drive cycles, driving process recording). It can be applied wherever traffic simulation has been successfully applied. (HWJ).

**20494 (PB—87-121729/XAB) Traffic mitigation reference guide: a review of options available to the public and private sectors.** Brittle, C.; McConnell, N.; O'Hare, S. (Metropolitan Transportation Commission, Oakland, CA (USA)). Dec 1984. 128p. NTIS, PC A07/MF A01.

See also PB—85-197804.

The document is a reprint of a guide on how to reduce traffic impacts, through city, developer, and employer actions. It covers a wide variety of techniques, including carpooling and vanpooling programs, transit usage, parking management approaches, variable work hours, bicycle programs, and various kinds of brokerage activities. The document also includes material on incorporation of traffic-mitigation techniques into local plans, policies, ordinances, and development project approvals, along with specific techniques for monitoring of compliance and enforcement. Funding of traffic-mitigation activities from public or private sources is also discussed. The document should be of interest to traffic and highway planners, the transit community, staffs of elected officials, major employers, and private developers themselves.

**20495 (PB—87-127353/XAB) Vessel performance system - Executive Summary. Final report, January 1985-June 1986.** White, D.R. (Cargo Carriers, Minneapolis, MN (USA)). Jul 1986. 19p. NTIS, PC A02/MF A01.

See also PB—87-127361.

The report presents a synopsis of the development of a prototype system that was designed to demonstrate an integrated approach to fuel management for river towboats. The concept involves combining power advisories for lower fuel consumption with rate-controlled steering for lower drag and increased ground speed.

**20496 (PB—87-127361/XAB) Vessel performance system. Final report, January 1985-June 1986.** White, D.R. (Cargo Carriers, Minneapolis, MN (USA)). Jun 1986. 30p. NTIS, PC A03/MF A01.

See also PB—87-127353; Color illustrations reproduced in black and white.

The report covers the development of a prototype system that was designed to demonstrate an integrated approach to fuel management for river towboats. The concept involves the combination of power advisories for lower fuel consumption with rate-controlled steering for lower drag and increased ground speed.

**20497 (PB—87-128666/XAB) Highway statistics, 1985. 40th anniversary edition, 1945-1985.** (Federal Highway Administration, Washington, DC (USA)). 1986. 205p. NTIS, PC A10/MF A01.

See also PB—86-156106.

The publication, the 41st of an annual series, presents the 1985 analyzed statistics of general interest on motor fuel, motor vehicles, driver licensing, highway-user taxation, State highway finance, highway mileage, and Federal aid for highways; and 1984 highway finance data for municipalities, counties, townships, and other units of local government. A listing of the data is given in the table of contents, and a brief description is given in the text accompanying each section.

**20498 (PB—87-131686/XAB) Katy freeway authorized vehicle lane: evaluation of the first year of operation. Research report, September 1983-September 1986.** Kuo, N.M.; Mounce, J.M. (Texas A and M Univ., College Station (USA). Texas Transportation Inst.). Sep 1986. 79p. (TTI—2-10-84-339-6). NTIS, PC A05/MF A01.

The report presents a first-year assessment of the performance of the high-occupancy vehicle facility which was implemented on the Katy Freeway (I-10W) in Houston, Texas. The facility is described, and data from the first year of operation are presented and analyzed. The data presented include park-and-ride demands, travel time changes, vehicle and passenger flow rates, accident experiences, and various transitway operating experiences. Before-and-after implementation comparisons are evaluated, and projected facility benefits and costs are provided.

## 3203 Industry And Agriculture

*REFER ALSO TO CITATION(S) 19918, 19990, 20098, 20169, 20460, 20462*

**20499 (DOE/BP/23462—1) Additional sawmill electrical energy study.** (Carroll, Hatch and Associates, Inc., Portland, OR (USA)). Feb 1987. Contract AC79-85BP23462. 82p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87006184.

This study was undertaken to investigate the potential for reducing use of electrical energy at lumber dry kilns by reducing fan speeds part way through the lumber drying process. It included three tasks: to quantify energy savings at a typical mill through field tests; to investigate the level of electric energy use at a representative sample of other mills and thereby to estimate the transferability of the conservation to the region; and to prepare a guide-

book to present the technology to mill operators, and to allow them to estimate the economic value of adopting the technique at their facilities. This document reports on the first two tasks.

20500 **(DOE/BP/23462—2) Guidebook to electrical energy savings at lumber dry kilns through fan speed reduction.** (Carroll, Hatch and Associates, Inc., Portland, OR (USA)). Feb 1987. Contract AC79-85BP23462. 45p. NTIS, PC A03/MF A01. File Number DE87006182.

Air circulating systems in kilns have been designed to operate at a single fixed speed. It has been recognized that the magnitude of air flow volume is less important as the lumber becomes drier. Depending upon a number of factors such as electrical energy costs, drying schedules, and kiln design, it may be advisable to equip kilns with the ability to vary air flow to more closely match actual reqirements. This process will result in reducing electrical energy, which saves kilowatthours, thereby directly reducing manufacturing costs. This booklet was written for the purpose of explaining the concept and guiding the reader through the process of analyzing potential for energy and expense reduction for dry kilns at the mill.

20501 **(EEO-ED—87-177) Microprocessor control of agitators in suspension storage tanks. A demonstration at Cookson Ceramics and Antimony Ltd. (formerly HMR Group Ltd.). Final Report.** (Department of Energy, London (UK). Energy Efficiency Office; Ove Arup and Partners, London (UK)). Aug 1986. 34p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751360.

Microprocessor control of agitators on 10 ceramic suspension storage tanks at the Joiners Square site of Cookson Ceramic and Antimony Ltd., has reduced running time by 90%. Applied to the site total of 87 agitators, this achieves energy savings of 549 MWh/year, equivalent to 6,590 GJ (249 tce) primary energy. The capital cost of the project was Pound 54,138, and the level of savings amount to Pound 18,160/year for electricity and Pound 29,950/year overall giving a simple payback period of 1.8 years. The project received support under the Energy Efficiency Demonstration Scheme in view of the potential energy savings, the new use of microprocessor technology, development possibilities and the opportunities for replication both within the ceramics industry and outside.

20502 **(EEO-ED—88-92) Heat recovery from an aluminium furnace for air pre-heating and stock drying. A demonstration at London and Scandinavian Metallurgical Co. Ltd. Final Report .** (Department of Energy, London (UK). Energy Efficiency Office; Warren Spring Lab., Stevenage (UK)). Aug 1986. 36p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751361.

By installing heat recuperation equipment on an existing furnace, the London and Scandinavian Metallurgical Co. Limited (LSM) achieved production cost savings calculated to be worth Pound 44,600/year. With plant and installation costs of Pound 67,500, the annual savings gave a payback period of only 18 months. The project which was partially funded by the Energy Efficiency Demonstration Scheme involved the installation of a cascade of heat exchangers to extract, from the flue gases, heat which could then be used to pre-heat the combustion air and incoming charges of ingots.

20503 **(EEO-ED—89) Recovery of waste heat in the glass industry.** (Department of Energy, London (UK). Energy Efficiency Office; UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; March Consulting Group, Birthwood (UK)). Aug 1986. 49p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751356.

A report is given of five heat recovery projects which have been undertaken in the glass industry with the support of the Energy Efficiency Demonstration Scheme. These projects were performed in the container sector and involved waste heat recovery using recuperative burners on the working end of a glass melting tank and waste heat recovery from a lehr at a float glass works. Of the five case studies, two can be regarded as well engineered solutions giving a satisfactory return on the capital investment.

20504 **(EEO-ED—90-203) Application of regenerative ceramic burners on an aluminium bulk melting furnace. A demonstration at Alcan Enfield Alloys Ltd. Final Report .** (Department of Energy, London (UK). Energy Efficiency Office; British Steel Corp., Rotherham. Swinden Labs.). Sep 1986. 57p. NTIS (US Sales Only), PC A04/MF A01. File Number DE87751362.

A report is given of a project involving the installation of a pair of regenerative ceramic burners in place of conventional natural gas burners on a 40-tonne forewell aluminium melting furnace at the Bradford plant of Alcan Enfield Alloys Ltd. The results of both short-term detailed trials and longer term records indicate a 28% reduction in energy usage resulting in annual energy cost savings of nearly Pound 39,000 with a 57 week simple payback period. The project was assisted by the Energy Efficiency Demonstration Scheme.

20505 **(EPRI-AP—4943) High-efficiency axial compressor: Final report.** Bettner, J.L.; Sehra, A.K. (General Motors Corp., Indianapolis, IN (USA). Allison Gas Turbine Operations; Electric Power Research Inst., Palo Alto, CA (USA)). Dec 1986. 311p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920186.

An aerodynamic design study was conducted to configure an industrial-size gas turbine compressor of 14.0:1 pressure ratio and 800 lb/sec flow for achieving maximum efficiency. Starting with an initial configuration based on conventional design practice, compressor design parameters were progressively optimized, leading to a 1.8% improvement in the adiabatic efficiency over that of the conventional design. To further improve the efficiency potential of this design, several advanced design concepts were investigated. It was found that incorporation of airfoils with swept leading edges and customization of the airfoil camber and endwall region would result in an additional adiabatic efficiency potential of 1%. The projected polytropic efficiency of the final advanced concept compressor design was estimated at 92.8%, which is 2 to 3% higher than the current high-efficiency aircraft turbine engine compressors. As a part of this design study, the influence of variable geometry on the flow and efficiency (at design speed) was also investigated. It was estimated that the efficiency decrement associated with a 25% reduction in the design flow, achieved by a system of variable inlet guide vanes and the front five stators, was about 4.0%. The corresponding efficiency penalty with variable IGV-only was estimated to be in excess of 10%.

20506 **(PB—87-128930/XAB) Haiti: energy efficiency in the sugar and manufacturing industries.** Streicher, A. (Hagler, Bailly and Co., Washington, DC (USA)). 28 Mar 1985. 55p. NTIS, PC PC E04/MF E01.

A review of energy use in Haiti, aimed at identifying possible projects to complement current A.I.D. support for institution building and energy planning within the Ministry of Mines and Energy Resources (MMRE), is presented. Key findings are that: (1) the sugar and manufacturing industries rely heavily on biomass fuels - wood, charcoal, and bagasse (sugar cane residue); and (2) demand for commercial energy and for electricity is growing rapidly despite supply constraints. The report calls for A.I.D. to: initiate a program to reduce biomass consumption (which is causing severe soil erosion and deforestation), especially in the small distilleries called guildives; collaborate with MMRE and the World Bank to develop a detailed workplan to promote energy efficiency in the guildives, focusing on technology development; help MMRE and the private sector to project Haiti's industrial energy and electricity needs through the year 2000; and sponsor a program of energy audits and efficiency improvements in the manufacturing sector.

20507 **(SBP-IEE-TM—96) Critical survey of control in refrigeration systems and heat pumps.** Wong, A.K.H.; James, R.W. (Polytechnic of the South Bank, London (UK). Inst. of Environmental Engineering). Jan 1986. 29p. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

A critical survey of the literature on control in refrigeration systems and heat pumps has been carried out. Capacity, defrost, condenser and safety controls are considered. It shows that re-

search in the refrigeration field is limited but in contrast, heat pumps have received more attention. Several areas for future research are identified.

20508 **Simulation of process economics for pioneer plants.** Williams, K.A.; Holmes, J.M. (Oak Ridge National Lab., Oak Ridge, TN 37831). *Chemical Engineering Progress;* 83: No. 1, 31-36(Jan 1987).

Successful and profitable operation of a future plant, be it a chemical or energy process facility, will depend on a planning process, in which well-informed decisions are made early in the process life cycle. If the life cycle is considered to consist of five time periods - R&D, engineering, plant deployment (construction), steady-state operation, and decommissioning - crucial planning decisions must be made during the first two of these periods. Economic projections regarding the future competitiveness of a process constitute a crucial planning tool for assisting the decision process. Such projections should be made early in the R&D program and again at a later development stage prior to a decision to proceed with a commercial facility. Risk factors must be considered for the projected overall performance and cost to be credible: i.e., the probability that under the assumed planning constraints the projected plant performance and cost targets may not be realized. (Risk in this context does not refer to the probabilities of accidents or the existence of other health and safety concerns.)

## 3206 Municipalities And Community Systems

20509 **(AD-A—175566/9/XAB) Feasibility study of Coal Gasification/Fuel Cell/Cogeneration economic and financing assessment.** Bos, P.; Rossi, B.; Estreich, P. (Ebasco Services, Inc., New York (USA)). Aug 1985. 179p. NTIS, PC A09/MF A01.

The purpose of this report is to describe the economic and financing feasibility assessment carried out for a Coal Gasification/Fuel Cell/Cogeneration (GFC) Project for 4 specific sites: Scranton Army Ammunition Plant in Pennsylvania, Ft. Greely Army Base in Alaska, Ft. Hood Army Base in Texas, and Georgetown University in Washington, D.C. The assessment presented in this document is part of an overall technical, economic, and financing feasibility study of power generation by a fuel cell using synthetic gas produced from coal. The concept involves selling the electric power and thermal output from the GFC plant to the site facility under a price structure that would produce significant energy-related cost savings for the site for the 20 years, 1990-2009.

20510 **(EEO-ED—86-165) Use of an oxygen trim control system on a steady load natural gas-fired pressurised hot water boiler. Final Report.** (Department of Energy, London (UK). Energy Efficiency Office; UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; British Gas Corp., Croydon. Technical Consultancy Service of Southeast Region). Aug 1986. 31p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751355.

A report is given of an Energy Demonstration project involving an $O_2$ trim control system as applied to a steady load, district heating type of hot water boiler at the University of Sussex. Results are presented for the ETC Boilermizer $O_2$ trim controller which monitors the flue gases leaving the boiler and trims the amount of air entering the burner. Overall energy savings of just over 1% for the boiler tested were achieved.

## 3209 Education And Public Relations

20511 **(PNL—6156) Energy Management Curriculum Starter Kit.** Turner, W.C. (Pacific Northwest Lab., Richland, WA (USA)). Feb 1987. Contract AC06-76RL01830. 103p. NTIS MF A01; 2; GPO Dep. File Number DE87006772.

The Energy Management Curriculum Starter Kit was designed to help engineering educators develop and teach energy management courses. Montana State University and Oklahoma State University courses are embodied in the model curriculum given. The curricula offered at many other universities throughout the United States are also presented. The kit was designed specifically to train engineering students to be good energy managers. Courses at both the undergraduate and postgraduate level are presented.

# 33 ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

20512 **(N—87-14427) High- and low-thrust propulsion systems for the space station.** Jones, R.E. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1987. 23p. (NASA-TM—88877; E—3285; NAS—1.15:88877; CONF-870133—4). NTIS, PC A02/MF A01.

From 25. AIAA aerospace sciences meeting; Reno, NV, USA (12 Jan 1987).

Sponsored by AIAA.

The purpose of the Advanced Development program was to investigate propulsion options for the space station. Two options were investigated in detail: a high-thrust system consisting of 25 to 50 lbf gaseous oxygen/hydrogen rockets, and a low-thrust system of 0.1 lbf multipropellant resistojets. An effort is also being conducted to determine the life capability of hydrazine-fueled thrusters. During the course of this program, studies clearly identified the benefits of utilizing waste water and other fluids as propellant sources. The results of the H/O thruster test programs are presented and the plan to determine the life of hydrazine thrusters is discussed. The background required to establish a long-life resistojet is presented and the first design model is shown in detail.

## 3301 Internal Combustion Engines

*REFER ALSO TO CITATION(S) 21035*

20513 **(AD-A—175155/1/XAB) Stochastic mixing model for predicting emissions in a direct-injection diesel engine. Doctoral thesis.** Brown, A.J. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Ocean Engineering). Sep 1986. 296p. NTIS, PC A13/MF A01.

A two-step approach for calculating slow and complex chemistry in inhomogeneous turbulent reactive flows, specifically in a direct-injection diesel engine, was developed and evaluated. The first step in this approach is to complete a multi-dimensional model (MDM) solution of the reactive flow. This was accomplished for a direct-injection diesel using the KIVA computer code developed at the Los Alamos National Laboratory. The output of this solution is used to define zones within the flow, and to calculate zone processes and mass flow between zones. A Stochastic Mixing Model (SMM) computer code was developed to recalculate turbulent mixing and chemistry using the MDM information. The SMM generates distributions of turbulent properties within each zone which are necessary to calculate slow emissions chemistry. The submodels included in the SMM are not intended to be unique, but only to represent one example of how this approach might be applied.

20514 **(AD-A—175229/4/XAB) Fabrication and testing of a ceramic two-cycle diesel engine. Final report, 29 November 1983-31 January 1986.** MacBeth, J.W. (Standard Oil Engineered Materials Co., Niagara Falls, NY (USA). Structural Ceramics Div.). 31 Mar 1986. 163p. NTIS, PC A08/MF A01.

The project effort was focused around evaluating the friction horsepower performance of a single-cylinder two-stroke opposed-piston diesel engine, fabricated from conventional metal components and then with the substitution of ceramic components for the cylinder liner and pistons. The ceramic configurations were run ringless and without cylinder lubrication. Frictional torque measurements were 50% lower than in the standard baseline case.

20515 **(AD-A—175305/2/XAB) Investigation of the oxide adhesion and growth characteristics on platinum-modified aluminide coatings. Master's thesis.** Farrell, M.S. (Naval Postgraduate School, Monterey, CA (USA)). Sep 1986. 61p. NTIS, PC A04/MF A01.

The operating environment for superalloy blades and vanes in gas turbine engines has necessitated the developed of alloy coatings to achieve satisfactory resistance of the metal to oxidation and hot corrosion. Aluminide coatings were initially developed to meet this need. Recently it was shown that platinum additions significantly improve the oxidation resistance of these aluminide coatings. The effects of pre-aluminizing surface smoothness and coating structure for both platinum modified and unmodified aluminide coatings on IN-738 in a cyclic oxidation environment at 1100 C were examined. Weight change measurements were used to determine the coating oxide scale adherence characteristics and to quantify the cyclic oxidation behavior of the various coating structures.

20516 **(NP—7770071) Influence of the fuel-air ratio at the spark plug on the flame initiation phase.** Almstadt, K. (Technische Univ. Braunschweig (Germany, F.R.). Fakultaet fuer Maschinenbau und Elektrotechnik). 26 Jun 1985. 185p. (In German). NTIS (US Sales Only), PC A09/MF A01. File Number DE87770071.

Energy conversion in the Otto-engine is characterized by a stray dispersion from one cycle to the next. The flame initiation phase causes the strongest disturbance, as it varies in length of time and thereby delays or advances the following conversion phase which finally changes the amount of energy transmitted to the crankshaft. This situation was studied in detail on an engine test stand where pressure, flame propagation, flow and temperature were measured. Details of the test stand structure, the measuring instruments, the data collection (digitalised) and evaluation of measured data are given. Dependence of the flame initiation phase on operating point, chamber shape temperature and density was investigated. The influence of residual gas was simulated by adding inert gas, the influence of flow at the spark plugs on the flame initiation was determined. Parameters which strongly influence the flame initiation are compared with each other. Examples for application of the information thus obtained are given: increase of mixture richness, switch-off of individual cylinders during partial-load operation, reduction of residual gas, higher flow velocity by means of swirl ducts. (HWJ).

20517 **(NP—7770073) Cylinder cut-off in an Otto-engine.** Sandten, U. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Maschinenwesen). 12 Nov 1984. 160p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87770073.

Cylinder cut-off, one of the known possibilities of low-loss fuel-air ratio control for an Otto-engine (others are: mixture temperature control, variable valve opening, variable series valve, single-throttle), was investigated. All useful concepts of cylinder cutoff, the achievable efficiency of an Otto-engine, measurement analysis and concepts of cylinder cut-off, comparison between the efficiency of throttle control and cylinder cutoff are described in detail. Deteriorating efficiency of throttle control methods and the causes for it are explained by describing the following processes: high combustion pressure, charge cycle losses, friction, cylinder drag. Some concepts are presented for cylinder cut-off especially at low speed and load (i.e. in the main operating range of a passenger car engine) which are expected to reduce fuel consumption more than the conventional throttle control system. (HWJ).

20518 **Direct measurement of the turbulent burning velocity in a homogeneous-charge engine.** Witze, P.O.; Lopes, J.M.C.M. Warrendale, PA; Society of Auto Engineers (1986). 9p. (CONF-861041—). Society of Auto Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.

From Society of Automotive Engineers international fuels and lubricants meeting and technical display; Philadelphia, PA, USA (6 Oct 1986).

An experiment is described for the direct measurement of the turbulent burning velocity during premixed combustion in a spark ignition engine. The gas velocity is measured using a high data rate laser Doppler velocimeter system that resolves the unburned gas motion on an individual cycle basis. The ensemble-averaged flame speed is determined from ionization probe measurements of the time of flame arrival at discrete positions along the path of flame propagation. The difference between the cycle-resolved unburned gas velocity and the ensemble-averaged flame speed gives a direct measurement of the turbulent burning velocity that is unbiased by cycle variations in the combustion rate.

20519 **Effects on charge non-uniformity on diesel heat release analysis.** Cheng, W.; Gentry, R. Warrendale, PA; Society of Auto Engineers (1986). 12p. (CONF-861041—). Society of Auto Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.

From Society of Automotive Engineers international fuels and lubricants meeting and technical display; Philadelphia, PA, USA (6 Oct 1986).

A new model that includes the effects of spatial non-uniformity for the heat release analysis of internal combustion engine data has been formulated. The model has a form similar to the simple single zone thermodynamic models if two effective values of the ratio of specific heats $\gamma$ are defined. These values, denoted by $\gamma$/sub v/ and $\gamma$/sub H/ in the model, are weighted spatial average values of $\gamma$, and are dependent on the structure of the flame. These values have been evaluated using a three-dimensional numerical simulation of diesel combustion. Then the model is applied to the heat release analysis of diesel combustion data from a Rapid Compression Machine.

20520 **Ceramics for automotive gas turbines.** Schulz, R.B. (U.S. Dept. of Energy, Washington, DC). pp 307-316 of Materials for future energy systems. Metals Park, OH; American Society for Metals (1984). (CONF-840570—).

From American Society for Metals materials for future energy systems conference; Washington, DC, USA (1 May 1984).

The government's current role in automotive gas turbine development is described. With an eye to shaping the future of the ceramic research upon which the Automotive Gas Turbine Program is dependent, a multiyear research plan has also been implemented, based on consultation with industry, which will pursue the technology needed to produce reliable and cost-effective structural ceramics.

## 3306 Vehicle Design Factors

20521 **(NP—7770069) Simulation of operation loads of a vehicle gear under dynamic stress.** Horst, J. (Hochschule der Bundeswehr, Hamburg (Germany, F.R.). Fachbereich Maschinenbau). Mar 1986. 151p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87770069.

Determining the service life of car gears in field and drive tests is a time-cost- and manpower-consuming method. To overcome these problems a test system was developed which allows to link calculations and tests directly which further permits direct observation and checking of changes of the system's parameters. This applies to damage as well as temperature and noise. Explanations of some basic facts on strength analysis of the component under dynamic stress and the problems of fatigue measuring are followed by details of service life analysis using simulation and component; i.e. test piece, computing program, test stand, coupling of computer and test stand, the simulation program axial dynamics (drive cycles, vehicle, distance covered, driver, gear shift, computing program), test stand control program, recording of measured values. Further details are supplied on the methods of evaluation: (selection of elements to be calculated, methods of calculation, selection of fatigue measuring methods, instruments for fatigue measuring, test program) and the results of calculations and fatigue measuring. Calculated and measured results are compared. (HWJ).

### 3307 Emission Control

*REFER ALSO TO CITATION(S) 20513*

### 3308 Alternative Fuels

*REFER ALSO TO CITATION(S) 20167, 20168*

## 35 ARMS CONTROL

**20522 (AD-A—175216/1/XAB) Robust Preallocated Preferential Defense Model.** Bracken, J.; Falk, J.E.; Tai, A.J.; Soland, R.M. (Institute for Defense Analyses, Alexandria, VA (USA)). Sep 1986. 173p. (IDA-P—1875). NTIS, PC A08/MF A01.

IDA Independent Research Program.

The Robust Preallocated Preferential Defense Model (RPPDM) treats the problem of protecting a specified number of targets, which may be identical or different, from attack by a number of weapons that may vary within a specified range. The targets are defended by a specified number of interceptors. The attacker is aware of the number of interceptors but not of their allocation to the defense of targets. The size of the attack is chosen by the attacker from within a specified range. The robust strategies determined in this model do not require the defender to assume an attack size. Rather, the defender chooses a strategy which is good over a wide range of attack sizes, though not necessarily best for any particular attack size. The attacker, knowing the defender is adopting a robust strategy, chooses the optimal attack strategy for the number of weapons he chooses to expend. The expected number of survivors is a function of the robust defense strategy and the optimal attack strategy against this robust defense.

**20523 (AD-A—175217/9/XAB) Monte Carlo Layered Defense Model. Final report.** Bracken, J. (Institute for Defense Analyses, Alexandria, VA (USA)). Sep 1986. 94p. (IDA-P—1966). NTIS, PC A05/MF A01.

IDA Independent Research Program.

The Monte Carlo Layered Defense Model includes boost-phase defense, midcourse defense, and terminal defense. It accounts for every offensive missile, RV, heavy decoy, and light decoy. For near-perfect defense of a value-target data base, the accounting for each RV through the succession of layers is critical, since it is not possible in advance to know if leakage or exhaustion will be the source of kill when the final events involve small integer interactions. The model is quite flexible. In the boost-phase layer, the options for battle management/command, control and communications (BM/C3) include random (decentralized), efficient (centralized), and preferential according to number of RVs on the missiles. In the midcourse layer, the BM/C3 options include random, efficient, and preferential, in which the attack is shaped such that it can be handled as well as possible by the terminal defense (in the heuristic sense, not in the guaranteed optimal sense). In the terminal layer a number of different attack and defense situations are represented. The example presented in the documentation gives test results for many combinations of defense force levels and BM/C3 capabilities.

**20524 (AD-A—175219/5/XAB) Value of area defense impact-point prediction in a two-layer defense with perfect attackers and defenders. Final report.** Finn, M.V. (Institute for Defense Analyses, Alexandria, VA (USA)). Sep 1986. 101p. (IDA-P—1902). NTIS, PC A06/MF A01.

IDA Independent Research Program.

A nationwide target data base is considered, containing targets of differing values. Each target is defended by a number of terminal interceptors corresponding to its value. Collections of targets are defended by area interceptors of longer range than the terminal interceptors. (The terminal interceptors are endoatmospheric and the area interceptors are exoatmospheric). The paper determines the effect of preferential as opposed to random subtractive area defense. For any specified percent of target damage value, the number of RVs required in the presence and the absence of impact point prediction is found. For the cases examined more than twice as many RVs can be required if the defense has impact point prediction. The value of maneuvering RVs to the attacker is the mirror image of the value of impact point prediction to the defender. If the RVs change direction after the exoatmospheric engagement, that engagement might as well have been random subtractive. Thus, the paper addresses both the defender's value of having impact-point prediction and the attacker's value of denying impact-point prediction.

**20525 (AD-A—175303/7/XAB) IIF (Intermediate-range Nuclear Forces) controversy: a confluence of foreign and domestic interests. Master's thesis.** Gick, P.J. (Naval Postgraduate School, Monterey, CA (USA)). Sep 1986. 147p. NTIS, PC A07/MF A01.

The study examines national interest theory in the light of the Intermediate-range Nuclear Forces (INF) controversy. The perceptions and positions of the United States, the Soviet Union, France, the United Kingdom, and several non-nuclear members of NATO are examined and analyzed. The analysis is concerned with alliance and transnational considerations, military capabilities, and domestic political constraints. Where necessary the historical and cultural perceptions, as well as the strategic requirements of the nation involved are factored in. The study concludes with an overview of the options available to the nations involved in the INF controversy.

**20526 (AD-A—175532/1/XAB) US declaratory policy on Soviet SSBN security: 1970 to 1985. Final research memorandum report.** Perse, J.D. (Center for Naval Analyses, Alexandria, VA (USA). Naval Warfare Operations Div.). May 1986. 39p. (CRM—84-29). NTIS, PC A03/MF A01.

U.S. defense officials have often said that the Soviet Union expects Western antisubmarine warfare (ASW) forces to attack its ballistic missile submarines (SSBNs) and thus is prepared to defend them in war. These Soviet expectations may have been encouraged by U.S. declaratory policy on the subject--that is, the totality of official and other authoritative statements on strategic doctrine and policy, ASW capabilities and tactics, and ASW technology and programs from which Soviet observers reach conclusions about U.S. intentions. This paper reviews U.S. declaratory policy between 1970 and 1985 to determine specifically what that policy has been and then to infer what it has probably meant to the Soviets. It concludes that throughout this period official U.S. declatory policy has implied an intent to engage in strategic ASW and that the Soviets have had strong reasons to believe that their SSBNs have been and will continue to be targets of U.S. ASW forces.

**20527 (AD-A—175600/6/XAB) Strategic defenses and the transition to assured survival. Interim report.** Kent, G.; de Valk, R. (RAND Corp., Santa Monica, CA (USA)). Oct 1986. 70p. (RAND/R—3369-AF). NTIS, PC A04/MF A01.

This report details the anatomy and calculus of the ballistic missile portion of the transition to a robust nationwide strategic defense posture as proposed by Pres. Regan 23 Mar 83. The authors develop an analytic format based on ballistic missile defense potential. The defense potential format demonstrates that, if highly survivable strategic defenses were deployed as an adjunct to current superpower ballistic-missile forces, the United States could make the transition to the President's goal of assured survival from ballistic missile attack without having to pass through a period during which either the U.S. or the USSR would have great incentive to launch a first strike against the other. If, however, the defenses are vulnerable to attack and/or both superpowers continue to deploy weapons capable of destroying hard targets but fail to adopt corresponding offensive force survivability measures, a stable transition would become less likely.

**20528 (AD-A—175577/6/XAB) Chemical weapons of the Soviet Union.** Fang, Y. (Air Force Systems Command, Wright-Patterson AFB, OH (USA). Foreign Technology Div.). 4 Dec 1986. Translation of Conmilit (China), Vol. 6, No. 3 (Issue 66), 28-32(1 May 1982). (FTD-ID(RS)T—0995-86). 19p. NTIS, PC A02/MF A01.

A chemical weapon consists of a toxicant and its spraying equipment. The toxicant itself is the fundamental part. Once a

chemical war starts, the toxicants probably to be used by the Soviet Union are the following: Phosgene, Mustard, Tabun, Sarin, Soman, Lewisite, Hydrocyanic acid, Chloroacetophenone, Adamsite, and Cyanogen Chloride.

# 36 MATERIALS

*REFER ALSO TO CITATION(S) 21021, 21706, 21707*

**20529 (UCRL-Trans—12151) Nothing, that pretended to be metal: Who held back development of an important direction in physics for a decade and how.** Ushanov, S. Translated from *Literaturnaia Gazeta ;* vp(25 Jun 1986). Contract W-7405-ENG-48. 10p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005350.

This nontechnical paper discusses E.N. Yakovlev's high-pressure compression experiments on nonmetallic substances. These substances appeared to have turned into metals by the high pressure, but this was only an effect from a trivial short circuit of the electrodes. He has not yet been removed from his post. (DLC)

**20530 Quautitative nondestructive evaluation: Vol.** Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). 955-1825p. (CONF-8506110—). Plenum Publishing Corp., New York, N.Y.

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This book provides comprehensive reviews of developments in the field of quantitatiative nondestructive evaluation. Information is presented on the following topics: ultrasonics and eddy currents; inversion, imaging and reconstruction; sensors and signal processing; systems and reliability; electronic materials and devices; composite materials; materials characterization; and federal science policy and technology transfer.

## 3601 Metals And Alloys

*REFER ALSO TO CITATION(S) 20123, 20133, 20133, 20235, 20235, 20235, 20314, 20315, 20326, 20332, 20360, 20362, 20381, 20384, 20385, 20389, 20434, 20515, 20725, 20726, 20843, 20917, 20918, 20919, 20920, 21460, 21718, 21733, 22027, 22039, 22039, 22039, 22042, 22043*

**20531 (AD-A—175514/9/XAB) Electron-number diagram for study of corrosion processes. Final report, 1 August 1984-31 July 1986.** Angus, J.C.; Zappia, M.J. (Case Western Reserve Univ., Cleveland, OH (USA)). 26 Sep 1986. 16p. NTIS, PC A02/MF A01.

The theoretical and experimental foundations of electron-number diagrams are being developed. These new diagrams provide a conceptual framework for interpreting and codifying the very complex chemical and phase equilbria that take place during practical corrosion processes. They also have utility in other areas such as electrodeposition, hydrometallurgy, and geochemistry. Work has on focused the single-redox-element systems Cu, Cr, Fe, S, and U and the two-redox-element systems Ga/As and Cd/Te.

**20532 (CONF-860917—15) Ceramic tritium breeder materials: Promise and performance.** Johnson, C.E.; Hollenberg, G.W. (Argonne National Lab., IL (USA); Hanford Engineering Development Lab., Richland, WA (USA)). 1986. Contract W-31109-ENG-38. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004717.

From 14. SOFT - symposium on fusion technology; Avignon, France (8 Sep 1986).

A critical element in the D-T fusion reactor design is the tritium-producing blanket. The lithium-containing ceramic materials $Li_2O$, $\gamma$-$LiAlO_2$, $Li_4SiO_4$, and $Li_2ZrO_3$ are being strongly considered as candidates for producing tritium. Materials properties data are being collected to provide a basis for evaluation and selection of a prime candidate material.

**20533 (CONF-861207—67) Effects of microadditions of cerium on annealing embrittlement in FeBSi glasses.** Kroeger, D.M.; McKamey, C.G.; Scarbrough, J.O. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005696.

From Materials Research Society fall meeting; Boston, MA, USA (1 Dec 1986).

Microadditions of cerium retard annealing embrittlement in some but not all metallic glass compositions in the FeBSi system. Effects on embrittlement of doping with both cerium and oxygen have been determined for a series of compositions, Fe/sub x/$B_{13}$Si/sub 87-x/. For X $\geqq$ 80, cerium retards annealing embrittlement and oxygen promotes it, suggesting that the beneficial effect of cerium additions results from gettering of impurities. The results indicate that for those compositions in the FeBSi system with the highest values of the saturation magnetization, M/sub s/, microadditions of cerium can prevent annealing embrittlement until the onset of crystallization.

**20534 (DOE/ER/13473—2) Chemisorption and reaction studies on well-characterized bimetallic and alloy surfaces: Progress report for period February 1, 1986-January 31, 1987.** Koel, B.E. (Colorado Univ., Boulder (USA)). Nov 1986. Contract FG02-86ER13473. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87006364.

We have explored the chemisorption of ethylene on well-characterized bimetallic surfaces consisting of potassium (K) or bismuth (Bi) coadsorbed on platinum (Pt), specifically Pt(111). The results of these studies are being compared in order to gain a better fundamental understanding of the role of electronic and geometric effects in modifying the chemistry of these surfaces. Site-blocking effects due to Bi decrease irreversible ethylene adsorption by increasing the barrier to dehydrogenation, while electronic effects due to K also produce a new weakly-bound $\pi$-state of adsorbed ethylene. The structure and bonding of adsorbed ethylene on these surfaces has been studied by vibrational spectroscopy using high-resolution electron energy-loss spectroscopy.

**20535 (DOE/ER/13560—1) Investigation of laser diagnostics of PACVD processes for depositing hard face coatings: Performance report for the period 1 July 1986-31 January 1987.** Roman, W.C. (United Technologies Research Center, East Hartford, CT (USA)). Feb 1987. Contract FG02-86ER13560. 4p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87006292.

Objective is to improve the understanding of the mechanisms which govern the nonequilibrium reactive plasma atomistic or molecular deposition of hard face coatings for erosion resistant applications. Goal is to provide a predictive capability that is severely lacking in the present science base of PACVD processing for depositing hard face coatings. Advanced laser diagnostics will be used to probe the plasma.

**20536 (EPRI-NP—5037) Causes of and corrective actions for pitting in steam generator tubing: Final report.** Smialowska, S. (Ohio State Univ., Columbus (USA). Dept. of Metallurgical Engineering; Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 152p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920305.

Pitting of Alloy 600 in dilute aqueous solutions of sodium and cupric chlorides was studied over the 60 to 280°C temperature range. The dependence on temperature of several parameters that are essential for the initiation of pits was determined. All parameters studied showed similar trends: a drastic decrease with temperature in pit nucleation potential, critical concentration of $CuCl_2$ necessary to initiation and corrosion potential in the range of temperatures 60 to 200°C and no significant change at higher temperatures.

**20537 (EPRI-NP—5072) Specially prepared alloy 600 tubing: Final report.** Monter, J.V. (Babcock and Wilcox Co., Alliance, OH (USA). Research and Development Div.; Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 259p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920309.

The susceptibility of alloy 600 steam generator tubing to primary and secondary side intergranular stress corrosion cracking (IGSCC) is significantly related to the microstructure which is developed during tube fabrication. The objective of the project was to produce tubing with both IGSCC susceptible and nonsusceptible microstructures by variations in annealing temperature and carbon content. Tubing made using low temperature anneals (927°C, 1700°F) and high carbon contents were most susceptible to IGSCC. Tubing given an anneal at a temperature greater than that required to dissolve carbon was shown to have the greatest resistance to IGSCC.

**20538 (FRADOC—8-3) ICONEL 690: a material with improved corrosion resistance for PWR steam generator tubes.** Smith, K. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). Sep 1985. 11p. (CONF-850902—12). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750993.

From 2. international symposium on environmental degradation of materials in nuclear power systems--water reactors; Monterey, CA, USA (9 Sep 1985).

This paper reviews the major aspects of the joint program carried out by the Commissariat a l'Energie Atomique, Electricite de France, Framatome and Westinghouse on the investigation of Inconel 690 (I.690) for use as PWR Steam Generator Tubing. The program was conceived as a further step in the long-term development of improvements in S.G. tube material corrosion resistance. Although the major emphasis of the work was on the corrosion resistance it was also necessary, in preparing for the commercial use of I.690 for S.G. tubing, to verify other aspects of behaviour in respect of physical and mechanical properties and for steam generator fabrication purposes. A key activity in the preparation for commercial use was the pre-production fabrication by a tube supplier of about 200 full-length tubes from each of three different heats. These tubes not only served the need to fully characterize the tubing (a requirement of the French specifications) but also provided a source of additional fully representative material for confirmatory corrosion and fabrication evaluation.

**20539 (GKSS—86/E/46) Correlation between decomposition structure and fatigue crack propagation in a copper-nickel-chromium alloy.** Heerens, J.; Schwalbe, K.H.; Jiang, B.; Wagner, R. (GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.); GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Werkstofftechnologie und Chemie; GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik). 1986. 63p. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE87751616.

The influence of microstructure on fatigue crack propagation in a spinodally decomposed Cu-32.2wt.%Ni-3.6wt.%Cr alloy was investigated. The fatigue crack propagation in an argon atmosphere was determined for four decomposition structures by measuring the crack propagation rate da/dN versus ΔK. These results show a significant influence of decomposition structure on fatigue crack propagation. For the determination of the slip-distribution ahead of the crack tip, fractographical investigation of the fracture surface and transmission electronmicroscopical investigation of the plastic zone were conducted. Correlations between slip-distribution and fatigue crack propagation were considered. With 51 figs., 1 tab.

**20540 (HEDL—7581) OWR [Omega West reactor]/ RTNS-II low exposure spectral effects experiment.** Heinisch, H.L.; Pintler, J.S. (Hanford Engineering Development Lab., Richland, WA (USA)). Feb 1986. Contract AC06-76FF02170. 7p. NTIS, PC A02. File Number DE87005497.

The status of the OWR/RTNS-II Low Exposure Spectral Effects Experiment is reviewed. The primary RTNS-II irradiations and six of the eight Omega West reactor (OWR) irradiations have been completed. Tensile tests on specimens from the first elevated temperature RTNS-II irradiation have been completed. Tests have begun on specimens irradiated in OWR. Yield stress and ultimate tensile strength as a function of 14 MeV neutron fluence are reported here for pure iron and A302B pressure vessel steel. Both exhibit a definite temperature dependence in their response to 14 MeV neutron irradiation. The first tensile data from OWR are compared to RTNS-II data at 90°C. When compared on the basis of dpa, the data for solution annealed 316 stainless steel correlate and those for copper do not.

**20541 (HEDL—7584) Transmutations in fusion test facilities.** Mann, F.M. (Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1986. Contract AC06-76FF02170. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004069.

Using an expanded nuclear data base, the transmutation of PCA, AMCR33 (a reduced activation austenitic steel), HT-9, Rafer2 (a reduced activation ferritic steel), V-15%Cr-5%Ti alloy, and SiAlON (a ceramic) were calculated for two positions in the Fast Flux Test Facility (FFTF), three positions in the High Flux Isotope Reactor (HFIR), and the first wall position of both the STARFIRE and MARS conceptual fusion reactors. The peripheral test (PTP) position, and to a lesser extent the radial beryllium (RB) position, of HFIR show significant transmutations which are often in the opposite direction to the transmutations in the fusion conceptual designs. The positions in FFTF, as well as the hafnium covered location in the HFIR RB position show relative minor transmutations.

**20542 (HEDL—7594) Swelling of pure copper and copper alloys after high fluence irradiation in FFTF [Fast Flux Test Facility] at approximately 450°C.** Garner, F.A.; Brager, H.R. (Hanford Engineering Development Lab., Richland, WA (USA)). Mar 1986. Contract AC06-76FF02170. 7p. NTIS, PC A02. File Number DE87005468.

The swelling of pure copper and various copper-base alloys has been determined at 47.2 dpa after irradiation in FFTF-MOTA at ~450°C. Data are also becoming available at 63.3 dpa. The alloys tend to fall into two broad categories, those that swell appreciably, sometimes with an S-shaped behavior, and those that resist swelling to very high neutron exposures. It appears that copper may have an intrinsic swelling rate of ~1%/dpa that is often not reached due to its tendency toward saturation of swelling. The most swelling-resistant alloys examined to date are CuAl25, MZC and Cu-2.0Be.

**20543 (HEDL—7626) Effects of substitutional alloying elements on microstructural evolution in neutron-irradiated Fe-10Cr.** Gelles, D.S. (Hanford Engineering Development Lab., Richland, WA (USA)). Dec 1986. Contract AC06-76FF02170. 13p. NTIS, PC A02. File Number DE87005488.

The effect of solute additions on microstructural development in the base alloy Fe-10Cr following neutron irradiation at 426°C to 33.5 dpa has been examined. Additions of Si, V, Mn, W, Ta, and Zr were considered at 0.1 and 1.0 wt % levels. It was found that solute additions affect the level of swelling, the void morphology and the dislocation evolution. The results are interpreted in terms of solute segregation to point defect sinks.

**20544 (HEDL—7630) Fusion materials specimens from MOTA-1C FFTF [Fast Flux Test Facility] Cycles 5-6.** Ermi, A.M. (Hanford Engineering Development Lab., Richland, WA (USA)). Oct 1985. Contract AC06-76FF02170. 11p. NTIS, PC A02. File Number DE87005492.

Tables of data are given for fusion materials that were irradiated under various neutron fluences. (MOW)

**20545 (HEDL—7631) Effects of low doses of 14-MeV neutrons on the tensile properties of three binary copper alloys.** Heinisch, H.L.; Pintler, J.S. (Hanford Engineering Development Lab., Richland, WA (USA)). Dec 1986. Contract AC06-76FF02170. 7p. NTIS, PC A02. File Number DE87005490.

Miniature tensile specimens of high purity copper and copper alloyed respectively with five atom percent of Al, Mn, and Ni were irradiated with D-T fusion neutrons in the RTNS-II to fluences up to 1.3 x $10^{18}$ n/cm$^2$ at 90°C. To compare fission and fusion neutron effects, some specimens were also irradiated at the same temperature to similar damage levels in the Omega West Reactor (OWR). Tensile tests were performed at room temperature, and the radiation-induced changes in tensile properties were examined as functions of displacements per atom (dpa). The irradiation-induced strengthening of Cu5%Mn is greater than that of Cu5%Al and Cu5%Ni, which behave about the same. However, all the alloys sustain less irradiation-induced strengthening by 14 MeV neutrons than pure copper, which is in contrast to the reported results of earlier work using hardness measurements. The effects of fission and fusion neutrons on the yield stress of Cu5%Al and Cu5%Ni correlate well on the basis of dpa, but the data for Cu5%Mn suggest that dpa may not be a good correlation parameter for this alloy in this fluence and temperature range.

20546 **(HEDL—7633) Spinodal-like decomposition of Fe-Ni and Fe-Ni-Cr alloys in both radiation and non-radiation environments.** Garner, F.A.; McCarthy, J.M. (Hanford Engineering Development Lab., Richland, WA (USA)). Dec 1986. Contract AC06-76FF02170. 15p. NTIS, PC A02. File Number DE87005496.

The radiation-induced development of spinodal-like compositional fluctuations in Fe-Ni-Cr invar alloys leads to several fortuitous methods of visualizing the three-dimensional nature of the decomposition process. In low dose neutron-irradiated Fe-Ni-Cr specimens, the use of high electropolishing rates during preparation of microscopy foils leads to a preferential attack of those regions which are low in nickel. In high dose ion-bombarded specimens of Fe-35Ni, the absence of chromium leads to formation of cellular martensite in the nickel-poor regions upon cooling to room temperature. The scale of the fluctuations at temperatures >600°C is comparable to that found in the Santa Catharina meteorite, which is roughly Fe-35%Ni in composition. This and other non-radiation data support the proposal that the Fe-Ni system in the absence of irradiation tends to spinodally decompose in the invar regime but at a very sluggish rate. Thus it appears that radiation accelerates rather than induces the decomposition of Fe-Ni and Fe-Ni-Cr invar alloys.

20547 **(HEDL-SA—3425-FP) The effects of low doses of 14 MeV neutrons on the properties of various commercial copper alloys.** Heinisch, H.L.; Martinez, C. (Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1986. Contract AC06-76FF02170. 19p. (CONF-860421—69). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005460.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Miniature tensile specimens of high purity copper and five copper alloys were irradiated with D-T fusion neutrons in the RINS-II to fluences up to 2.5 x $10^{22}$ n/m$^2$ at 90 and 290°C. The series of alloys includes solution-strengthened, precipitate-strengthened and dispersion-strengthened alloys. To compare fission and fusion neutron effects, some of the alloys were also irradiated at the same temperatures to similar damage levels in the Omega West Reactor. Tensile tests were performed at room temperature, and the radiation-induced changes in tensile properties are examined as functions of fluence and displacements per atom (dpa). All the alloys sustain less irradiation-induced strengthening than pure copper. In contrast to pure copper, the effects of fission and fusion neutrons on the yield stress changes in the copper alloys correlate well on the basis of dpa.

20548 **(HEDL-SA—3495-FP) Evaluation of defect production cross sections and calculated fission-fusion neutron spectrum sensitivity.** Simons, R.L. (Hanford Engineering Development Lab., Richland, WA (USA)). Mar 1986. Contract AC06-76FF02170. 33p. (CONF-860421—71). NTIS, PC A03/MF A01; GPO Dep. File Number DE87005472.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

A method is presented of semi-empirically deriving PKA cross sections for production of Frenkel pairs produced by irradiation of pure metals at liquid helium temperatures. Cross sections were developed for copper, silver, molybdenum, and tungsten derived by this method. Neutron cross sections which were calculated by Heinisch and Mann for mobile and clustered defects in copper were applied to a wide range of fission and fusion neutron spectra. These defect cross sections were developed from the computer simulation of the production and annealing of isolated binary collision cascades. The total number of defects per cascade were normalized to the semi-empirically derived PKA cross section for the production of Frenkel pairs by selecting an appropriate recombination radius. A study of the spectral sensitivity of mobile and clustered defects reveals that the relative numbers of mobile defects will be spectrally sensitive while clustered defects will be relatively insensitive to differences between fusion and most fission neutron spectra.

20549 **(INIS-SU—399, pp 15-16) Method of determination of an inhomogeneity size distribution in solid body by means of cold neutrons.** Antonov, A.V.; Beryuleva, N.S.; Isakov, A.I.; Meshkov, I.V.; Perekrestenko, A.D.; Shelagin, A.V. 1986. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87780091.

Kratkie Soobshcheniya po Fizike. No. 4.

In Experimental and theoretical data. Collection.

The method of determination of sizes of submicroscopic medium inhomogeneities as a function of macroscopic cross sections of elastic incoherent scattering on wavelengths of ultracold neutrons is developed. Inhomogeneity size distribution is obtained for beryllium within approximately 0.5-10nm wavelength range. 2 refs.; 2 figs.

20550 **(JAERI-M—86-003) Studies on the quality optimization of Hastelloy alloy XR.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1986. 232p. (In Japanese). NTIS (US Sales Only), PC A11/MF A01. File Number DE87701016.

Interim results are reported on the multi-lateral joint research program on improving quality and its assurance basis of Hastelloy alloy XR with special emphasis placed on the effect of small amount of boron in the alloy. In the first phase work the exploratory examination on the optimum boron content was made. The results of the tests on several key items yield the optimum range of boron content as 40 to 70 ppm. The second phase work was organized to perform qualification tests on an industrial scale heat, which was specified its boron content (40 ppm) based on the previous phase work. The tests included weldability, tensile and creep-rupture properties, post aging toughness and corrosion and carburization resistance on different type of products. Tests are in progress, in which considerable difference in the degree of improvement was noted between plate and tube.

20551 **(N—87-14374) Proceedings of the SMRM Degradation Study Workshop.** (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). 1985. 351p. (NASA-TM—89274; REPT—408-SMRM-79-0001; NAS—1.15:89274; CONF-8505348—). NTIS, PC A16/MF A01.

From SMRM degradation study workshop; Greenbelt, MD, USA (9 May 1985).

The proceedings of the Solar Maximum Repair Mission Degradation Study Workshop, held at the Goddard Space Flight Center in Greenbelt, Maryland on May 9 to 10, 1985 are contained. The results of tests and studies of the returned Solar Maximum Mission hardware and materials are reported. Specifically, the workshop was concerned with the effects of four years' exposure to a low-Earth orbit environment. To provide a background for the reported findings, the summary includes a short description of the Solar Maximum Mission and the Solar Maximum Repair Mission.

20552 **(N—87-14483) Cyclic stress-strain behavior of PWA 1480 at 650 deg C.** Gabb, T.P.; Welsch, G.E. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1986. 16p. (NASA-TM—87311; E—3038; NAS—1.15:87311; CONF-860340—15). NTIS, PC A02/MF A01.

From 115. American Institute of Mining, Metallurgical and Petroleum Engineers annual meeting; New Orleans, LA, USA (2 Mar 1986).

The monotonic plastic flow behavior of several single crystal nickel-base, superalloys has been shown to vary significantly with crystallographic orientation. In the present study, the cyclic plastic flow response of one such alloy, PWA 1480, was examined at 650 deg C in air. Single crystal specimens aligned near several crystallographic directions were tested in fully reversed, total-strain-controlled low cycle fatigue tests at a frequency of 0.1 Hz. The cyclic stress-strain response and general cyclic hardening behavior was analyzed as a function of crystallographic orientation and inelastic strain range.

20553 **(PNL-SA—14370) Grain boundary composition effects on environmentally induced cracking of engineering materials.** Bruemmer, S.M. (Pacific Northwest Lab., Richland, WA (USA)). Sep 1986. Contract AC06-76RL01830. 14p. (CONF-870314—9). NTIS MF A01; 2; GPO Dep. File Number DE87006405.

From Corrosion '87; San Francisco, CA, USA (9 Mar 1987).

There is now clear evidence that intergranular stress corrosion cracking (SCC) and hydrogen embrittlement (HE) of engineering materials depend on grain boundary composition. Two examples are used to illustrate this interrelationship: (1) SCC of austenitic stainless steel in high-temperature water and (2) HE of NiCrMoV rotor steels in acidic solutions. Grain boundary compositions are characterized by analytical electron microscopy and scanning Auger electron spectroscopy. Environmental cracking susceptibility is indicated by slow-strain-rate tests in appropriate aqueous environments. Direct correlations are documented between measured grain boundary compositions and environmental cracking. The ability to establish these types of correlations enables diagnosis of embrittlement susceptibility and helps identify methods to control or eliminate embrittlement by bulk chemistry or processing modifications. 7 figs., 3 tabs.

20554 **On the grain-boundary phase in iron rare-earth boron magnets.** Ramesh, R.; Chen, J.K.; Thomas, G. (Department of Materials Science and Mineral Engineering and National Center for Electron Microscopy, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Journal of Applied Physics;* **61**: No. 8, 2993-2998(15 Apr 1987). Contract AC03-76SF00098.

Results of structural and microanalytical studies on sintered iron rare-earth boron permanent magnets are presented in this paper. It is shown that the structure of the phase present at the two-grain boundaries is the same as that of the phase at the three-grain junctions; both are fcc with a lattice parameter of 5.24 A. It is also shown that this fcc phase is stabilized by the presence of significant quantities of oxygen. The possible effects of thin foil preparation by ion milling techniques in producing the observed bcc phase are also briefly discussed.

20555 **Positronium time-of-flight spectroscopy of dissimilar metals.** Howell, R.H.; Rosenberg, I.J.; Fluss, M.J.; Goldberg, R.E.; Laughlin, R.B. (Lawrence Livermore National Laboratory, University of California, Livermore, California 94550). *Physical Review [Section] B: Condensed Matter;* **35**: No. 10, 5303-5306(1 Apr 1987).

Positronium velocity distributions using the time-of-flight technique have been determined for positronium emitted from clean, well-annealed, single-crystal samples of Al(111), Cu(100), Ni(100), and Au(100). The positronium energy distribution had a similar shape for all samples and was consistent with the hypothesis that positronium formation leaves behind a single electron hole in the conduction band of the metal. This was verified by explicit calculation for Ni, the first d-band metal to be studied by this technique.

20556 **Martensitic phase transformation of single-crystal lithium from bcc to a 9R-related structure.** Smith, H.G. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review Letters;* **58**: No. 12, 1228-1231(23 Mar 1987). Contract AC05-84OR21400.

A neutron elastic- and inelastic-scattering study of single-crystal bcc lithium was performed above and below the martensitic phase transformation in the vicinity of 75 K. The transformation is abrupt and the bcc lattice partially transforms to a 9R-related (Sm-type) structure. The 9R c/sup */ and a/sup */ axes of this variant are nearly along the [110] and [11-bar0] bcc directions, respectively. The (10L) and (20L) 9R reflections were broadened and shifted from their ideal positions compared to the (00L) 9R reflections, indicative of numerous stacking faults. On warming, the sample reverts back to a single crystal with the same bcc orientation.

20557 **Lamb waves in unsupported thin films: A Brillouin-scattering study.** Grimsditch, M.; Bhadra, R.; Schuller, I.K. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review Letters;* **58**: No. 12, 1216-1219(23 Mar 1987). Contract W-31-109-ENG-38.

Using Brillouin scattering we have succeeded in observing the normal modes of vibration of unsupported films in a region where the dispersion relationship is quadratic. Extremely low-lying excitations were observed in thin films with thicknesses as small as 200 A. Contrary to what has been found in work on supported films, we are able to extract information on a number of the elastic moduli because the measured velocities in very thin films do not depend on the properties of the substrate. This technique should be a valuable addition to the tools which can be used in the study of materials in thin-film form.

20558 **Electronic structure of $M_3$/sup I/Sb-type filled tetrahedral semiconductors.** Wei, S.; Zunger, A. (Solar Energy Research Institute, Golden, Colorado 80401). *Physical Review [Section] B: Condensed Matter;* **35**: No. 8, 3952-3961(15 Mar 1987). Contract AC02-77CH00178.

First-principles band-structure and total-energy calculations have been performed for $Li_3Sb$, $K_3Sb$, and $Cs_3Sb$ in the cubic $D0_3$ structure. The structure of these $M_3$/sup I/A/sup V/ octet semiconductors consists of a face-centered-cubic lattice A/sup V/ in which three metal M/sup I/ atoms occupy the interstitial sites, thereby completing the octet shell. The equilibrium lattice parameters and bulk moduli calculated from the total energy agree well with available experimental data. The semiconducting character of $K_3Sb$ and $Cs_3Sb$ is attributed to p-d repulsion between the anion p states and the unoccupied metal d states. The calculated charge density shows weak covalent bonding between like atoms and ionic bonding between unlike atoms. The covalency decreases and the ionicity increases with increasing metal atomic number, as the $M^+$ cores dilate the lattice. We find that the electronic structure of these compounds can be understood qualitatively by considering a skeleton of Sb/sup 3-/ anions whose separation is determined by the otherwise nearly inert alkali ions $M^+$. The trends in the electronic properties in the series M = Li, K, and Cs then reflect the perturbations exerted by different $M^+$ ions through (I) charge transfer, (II) p-d hybridization, and (III) relativistic effects.

20559 **Nuclear magnetic resonance study of the bonding and diffusion of CO chemisorbed on Pd.** Shore, S.E.; Ansermet, J.; Slichter, C.P.; Sinfelt, J.H. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Physical Review Letters;* **58**: No. 9, 953-956(2 Mar 1987). Contract AC02-76ER01198.

The authors report use of /sup 17/O and /sup 13/C NMR to study the bonding of CO on Pd particles. By /sup 17/O-/sup 13/C double resonance, they measure the CO bond length to be 1.20 +- 0.03 A. The /sup 13/C resonance frequency is exceptionally high, 310 ppm above values typical for metal carbonyls. Evidence that the shift arises from electron-spin polarization is given from studies of the magnitude and the dependence on temperature and frequency of the /sup 13/C spin-lattice relaxation time. A diffusion enegy of 6 +- 2 kcal/mole, half that of CO on Pt, is deduced from motional narrowing of the /sup 13/C NMR line.

20560 **Effects of temperature and composition on the thermal and electrical conductivities of $Ni_3Al$.** Williams, R.K.; Graves, R.S.; Weaver, F.J. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Applied Physics;* **61**: No. 4, 1486-1492(15 Feb 1987). Contract AC05-84OR21400.

The results of a study of the thermal conductivity, electrical resistivity, and Seebeck coefficient of $Ni_3Al$ are described. The thermal and electrical conductivities are sensitive to composition and attain their maximum values in well-ordered, stoichiometric $Ni_3Al$. Nonstoichiometry (antisite defects), and Fe (a substitutional solute) and B (an interstitial solute) contents are all about equally effective in reducing the transport properties. Even for stoichiometric $Ni_3Al$, the temperature variation of the thermal and electrical conductivities resembles that of an alloy, and this is attributed to scattering associated with the loss of ferromagnetic order at —60 K. Experimental data and a theoretical analysis show that phonon conduction is an important part of the thermal conductivity and not very sensitive to composition or stoichiometry.

20561 **Appearance-potential spectroscopy and work function.** Gordon, R.L. (Pacific Northwest Laboratory, P.O. Box 999, Richland, Washington 99352). *Journal of Applied Physics;* **61**: No. 4, 1523-1532(15 Feb 1987). Contract AC06-76RL01830.

Methods and procedures are described which permit the use of a commercial scanning Auger microprobe (SAM) to obtain work-function measurements at the geometrical resolution routinely achieved in surface composition determinations. The work function is estimated by the appearance potential for secondary electrons. The need for auxiliary circuitry has been eliminated by the development of methods to access the existing interface between the SAM and its computer control. High-level computer languages are used to obtain coincident appearance potential and Auger spectra. A discussion of the relationship between appearance potential and work function is presented. It is shown that the difference between work function and appearance potential depends on the radius R of a work-function patch and the vertical distance to the surface potential barrier maximum, x*. For small x*/R the appearance potential is a good estimate of work function. The technique is illustrated by results obtained from surfaces with nonuniform coverages of residual gases.

20562 **Fe and Mn sites in noncrystallographic alloy phases of Al-Mn-Fe and Al-Mn-Fe-Si.** Ma, Y.; Stern, E.A. (Physics Department, University of Washington, Seattle, Washington 98195). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 6, 2678-2681(15 Feb 1987).

We report the results of extended x-ray absorption fine-structure investigations on the Mn and Fe edges of icosahedral $Al_{74}$(Mn/sub 0.88/Fe/sub 0.12/)$_{20}Si_6$ and decagonal $Al_{79}$(Mn/sub 0.88/Fe/sub 0.12/)$_{21}$. Fe and Mn sites in both alloys are compared directly. No significant difference was found between radial distributions around Mn and Fe atoms in the icosahedral sample. However, the distribution around Mn atoms has a broader distribution than that around Fe atoms in the decagonal phase. Implications of these results are discussed.

20563 **Force and total-energy calculations for a spatially compact adsorbate on an extended, metallic crystal surface.** Feibelman, P.J. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 6, 2626-2646(15 Feb 1987). Contract AC04-76DP00789.

A first-principles, scattering-theory formalism is presented for the calculation of the energy of, and forces on, a spatially localized group of atoms in proximity to a metallic crystalline surface. A formula is derived for the adsorption energy which is rapidly convergent both with respect to the size of the matrix equations that must be solved and the number of mesh points required in the numerical computation of the matrix elements of the electron-electron potential. The force formula, following the method of Pulay, guarantees the tangency of the calculated force to the adsorption-energy surface if both are calculated using accurate solutions to the local-density-functional energy-minimization problem. The force formula thereby provides a useful internal consistency check on the calculations as well as a rapid means of finding adsorption equilibrium geometries, vibrational force constants, etc. Results of implementing the formalism are reported for the case of a single Al atom adsorbed on a two-layer Al(001) film, highlighting the close agreement of the calculated values of adsorption energy and the force on the adsorbed Al.

20564 **Elementary pinning force for a superconducting vortex.** Hyun, O.B.; Finnemore, D.K.; Schwartzkopf, L.; Clem, J.R. (Ames Laboratory-United States Department of Energy and Department of Physics, Iowa State University, Ames, Iowa 50011). *Physical Review Letters;* **58**: No. 6, 599-601(9 Feb 1987). Contract W-7405-ENG-82.

The elementary pinning force f/sub p/ has been measured for a single vortex trapped in one of the superconducting layers of a cross-strip Josephson junction. At temperatures close to the transition temperature the vortex can be pushed across the junction by a transport current. The vortex is found to move in a small number of discrete steps before it exits the junction. The pinning force for each site is found to be asymmetric and to have a value of about 10/sup -6/ N/m at the reduced temperature, t = T/T/sub c/ = 0.95. As a function of temperature, f/sub p/ is found to vary approximately as (1-t)/sup 3/2/. .AE

20565 **Computer simulations to study the explosive consolidation of powders into rods.** Reaugh, J.E. (University of California, Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Applied Physics;* **61**: No. 3, 962-968(1 Feb 1987). Contract W-7405-ENG-48.

In the direct method of explosive consolidation, metal or ceramic powder to be consolidated is placed in a metal tube, which in turn is surrounded by a concentric cylinder of explosive. The explosive is detonated at one end so that the detonation front moves axially along the powder-filled tube. The desired result is a crack-free, uniformly consolidated rod with the density of the starting material. At present, the wall thickness of the hollow cylinder of explosive that best produces the desired result is determined by experiment. We present the results of computer simulations revealing details of this dynamic process that are difficult to obtain experimentally. The simulations show that the best thickness depends on the equations of state of both explosive and powder. Such simulations can guide changes to the experimental geometry, even when approximate equations of state are used, although the best explosive and its thickness must ultimately be determined by experiment.

20566 **Strong electronic correlations in a new class of Yb-based compounds: $YbXCu_4$ (X = Ag,Au,Pd).** Rossel, C.; Yang, K.N.; Maple, M.B.; Fisk, Z.; Zirngiebl, E.; Thompson, J.D. (Department of Physics and Institute for Pure and Applied Physical Sciences, University of California, San Diego, La Jolla, California 92093). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 4, 1914-1918(1 Feb 1987).

A new series of heavy-electron Yb compounds $YbXCu_4$ with X = Ag, Au, or Pd are reported which have electron effective masses as high as —60m/sub e/, where m/sub e/ is the mass of the free electron. Whereas the compounds with X = Au and Pd order magnetically below 1 K, the compound with X = Ag is nonmagnetic. The magnetic susceptibility and specific heat of $YbAgCu_4$ can be accounted for by the Bethe-ansatz solution of the Coqblin-Schrieffer impurity model without any adjustable parameters.

20567 **Secondary-ion emission from clean and oxidized aluminum as a function of incident ion mass and energy.** Blauner, P.G.; Weller, R.A. (A.W. Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06511). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 4, 1492-1499(1 Feb 1987).

Measurements of the intensities of low-energy secondary ions emitted from clean and oxidized polycrystalline aluminum surfaces under (15—275)-KeV $He^+$, $Ne^+$, $Ar^+$, $Kr^+$, and $Xe^+$ bombardment are reported. An additional measurement of the secondary-ion mass spectrum obtained from a clean Al surface under 40-MeV Br/sup 5+/ bombardment is also presented. By varying both the beam energy and mass over such a large range, we have been able to identify three distinct categories of secondary ions. The first cate-

gory includes the metallic-ion species emitted from the oxide surface. The intensities of these ions are observed to be proportional to the sputtering yield of aluminum, indicating that they are produced by means which are consistent with several of the mechanisms already proposed to explain oxygen-enhanced secondary-ion emission from metals. The second category includes both singly and multiply charged Al ions from the clean surface as well as multiply charged ions from the oxide surface. Under high-energy bombardment, these ions all appear to be produced by the kinetic mechanism which has been proposed to explain multiply charged ion emission from Al under lower-energy bombardment. The third category of secondary ions identified includes only $O^+$ emitted from the oxide surface. This species, although usually a small component of the spectrum, is produced by means wholly unrelated to elastic energy deposition. Its production cannot be explained by any of the proposed models of metallic secondary-ion emission. The possibility that $O^+$ is produced by a mechanism similar to that of electron-stimulated desorption is discussed.

20568 **Method of beam welding metallic parts together and apparatus for doing same.** Lewandowski, E.F.; Cassidy, D.A.; Sommer, R.G. (to Dept. of Energy, Washington, DC). US Patent 4,639,571. 27 Jan 1987. Filed date 29 Nov 1985. vp.

A method is described of welding an elongated metallic piece to one side of a metallic plate from the opposite other side of such plate, such method comprising the steps of temporarily clamping the elongated piece to such one side of the plate while leaving the opposite side of the plate exposed, the clamped piece and plate initially having an interface tracing an elongated path therebetween with interstices along the plate, providing a heat conductive heat sink material, and configuring such material to engage such piece, and such plate on the one side, each at locations proximate to but spaced from the interface, subjecting the other side of such plate to an electron welding beam, focused narrowly at and in registry opposite to the elongated clamped piece, moving the electron welding beam along the elongated path in opposite registry to the elongated clamped piece, the electron welding beam being supplied with adequate energy for penetrating through the plate, across the interface, and into the piece, whereby the electron welding beam produces molten material from the plate and piece at the interface, the heat sink material sufficiently cooling the plate and piece proximate to but not at the interface, and preventing thereby the molten material from extruding from the interface, but instead of filling the interstices and providing a welded joint substantially void of interstices.

20569 **TiC, Ti, and C as a mixing barrier for Ni-Si ion beam mixing.** Nastasi, M.; Hirvonen, J.; Caro, M.; Rimini, E.; Mayer, J.W. (Materials Science and Technology Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Applied Physics Letters;* **50**: No. 4, 177-179(26 Jan 1987).

The effect of thin titanium carbide layer on the ion beam mixing of Ni and Si was studied. No mixing was observed following the ion beam bombardment at 600 keV to the fluence of 8 x $10^{15}$ $Xe^{++}/cm^2$. Furthermore, it was also found that Ti and C layers alone could prevent an ion beam mixing between Ni and Si, although in the Ti case mixing did occur between Ti and Ni. These results were compared to a thermodynamic model of ion mixing and found to be in qualitative agreement but relative quantitative agreement was poor.

20570 **Effects of segregation on grain-boundary cohesion: A density-functional cluster model of boron and sulfur in nickel.** Painter, G.S.; Averill, F.W. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review Letters;* **58**: No. 3, 234-237(19 Jan 1987). Contract AC05-84OR21400.

Impurity-dopant effects on grain-boundary cohesion have been studied in a first-principles local spin-density atomic-cluster model of octahedral hole sites in nickel. Rigorous calculations of the total energy and gradient forces on the host atoms show that boron (an enhancer of cohesion) increases the maximum sustainable restoring force in the cluster, and sulfur (an embrittler) decreases the value of this force, consistent with observed segregation behaviors of these atoms.

20571 **Electronic and magnetic properties of the fcc Fe(001) thin films: Fe/Cu(001) and Cu/Fe/Cu(001).** Fu, C.L.; Freeman, A.J. (Department of Physics and Astronomy, Northwestern University, Evanston, Illinois 60201). *Physical Review [Section] B: Condensed Matter;* **35**: No. 3, 925-932(15 Jan 1987).

All-electron total-energy local-spin-density studies of the electronic and magnetic properties of fcc Fe(001) as overlayers or sandwiches with Cu(001) were undertaken in order to understand the following: (1) the surface (interface) magnetism of fcc Fe(001), (2) the effect of nonmagnetic Cu on the magnetization of Fe and (3) the effect of the reduced coordination number on the magnetic coupling of Fe layers near the surface and interface. From our systematic studies of (i) one and two layers of Fe on Cu(001) and (ii) one and five layers of Fe sandwiched by Cu, it is concluded that the Fe magnetic moment is enhanced on the surface (to 2.85mu/sub B/) and the surface (interface) Fe layer is predicted to couple ferromagnetically to the subsurface (subinterface) Fe layer (in contrast to the antiferromagnetic behavior in the bulk fcc Fe). The effect of the nonmagnetic Cu overlayers decreases slightly (by 0.25μ/sub B/) the magnetic moments of Fe at the Fe/Cu interface from those of the free-standing surfaces, indicating the persistence of the two-dimensional magnetization at the interface. Magnetic hyperfine fields are compared among various magnetic states; the interface Fe atoms are found to experience a larger hyperfine field than the inner layers for the magnetic ground state due to the retention of antiferromagnetic coupling between Fe layers away from the interface. Electronic charge-density, work-function, and single-particle spectra are presented and discussed. The calculated energy dispersions agree well with a recent photoemission measurement by Onellian et al.

20572 **Generalized Ramsauer-Townsend resonance in angle-resolved photoemission extended fine-structure oscillations.** Barton, J.J.; Hussain, Z.; Shirley, D.A. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720 and Department of Chemistry, University of California, Berkeley, California 94720). *Physical Review [Section] B: Condensed Matter;* **35**: No. 3, 933-938(15 Jan 1987). Contract AC03-76SF00098.

We observe a resonance in the scattering amplitude for S(1s) photoelectrons from Ni atoms and interpret this resonance as a dip in the Ni atom partial cross section for electron scattering related to the Ramsauer-Townsend effect. This generalized Ramsauer-Townsend effect occurs at a particular energy and angle rather than in the total elastic cross section. We show that the resonance energy is sensitive to curved-wave corrections and, after including multiple-scattering effects, we derive the S: Ni bond length in c(2 x 2)S/Ni(100) from the angle-resolved photoemission extended fine-structure oscillations arising from the scattering of S(1s) photoelectrons off of nearest-neighbor Ni atoms in the presence of the generalized Ramsauer-Townsend resonance. We find this bond length to be 2.20 +- 0.03 A corresponding to a S-Ni interplanar distance (d/sub perpendicular/) of 1.32 +- 0.04 A.

20573 **Formation and destruction of the heavy-electron ground state in U compounds with $AuBe_5$ crystal structure.** Ott, H.R.; Rudigier, H.; Felder, E.; Fisk, Z.; Thompson, J.D. (Laboratorium fuer Festkoerperphysik, Eidgenoesische Technische Hochschule Zurich-Hoenggerberg, 8093 Zuerich, Switzerland). *Physical Review [Section] B: Condensed Matter;* **35**: No. 3, 1452-1455(15 Jan 1987).

The strong influence of changes of the chemical composition on the formation of a heavy-electron ground state is demonstrated in uranium intermetallic compounds crystallizing in the cubic $AuBe_5$ structure. The most spectacular effect is the large enhancement of the low-temperature electronic specific heat in $UPt_5$ when one Pt atom per formula unit is replaced by Au. $UAuPt_4$ may be a heavy-electron superconductor.

20574 **Half—flux-quantum magnetoresistance oscillations in disordered metal rings.** Li, Q.; Soukoulis, C.M. (Ames Laboratory-USDOE and Department of Physics, Iowa State University, Ames, Iowa 50011). *Physical Review Letters;* **57**: No. 24, 3105-3108(15 Dec 1986). Contract W-7405-ENG-82.

The behavior of the magnetoresistance of single and arrays of disordered metal rings is investigated. The average localization length, L/sub c/, which is related with the conductance, is found to oscillate with strong half-flux quantum harmonic at low magnetic field. The ratio of the amplitude of the full-flux oscillations versus the half-flux oscillation is shown to decrease with the number of rings. All numerical results follow a universal law where the amplitude of oscillations of L/sub c/ is found to be proportional to the square of the ratio of L/sub c/ to the perimeter of the ring. At high magnetic fields, full-flux oscillations are observed.

20575 **The formation of multilayer scales on pure metals.** Hsu, H.S. (Oak Ridge National Lab., Oak Ridge, TN). *Oxidation of Metals;* **26**: No. 5-6, 315-332(Dec 1986).

A quantitative theory for the growth of three-layered oxide scales on pure metals that form Me /SUB v/ O, Me /SUB s/ O, and Me /SUB e/ O has been developed. The theroretical parabolic rate constants, K /SUB p/ (Me /SUB v/ O), K /SUB p/ (Me O), and K /SUB p/ (Me O), for the simultaneous growth of each oxide on metals are related to oxidation data of the overall rate constant, K /SUB p/ , and the oxide thickness ratios. These theoretical parabolic rate constants can also be calculated from diffusion data in each oxide, and the oxide thickness ratios can therefore be predicted. To verify the validity of the theory, it was applied to the oxidation of iron in air at temperatures of 800 to 1200 degrees C. Good agreement was found between the theoretical parabolic rate constants calculated from oxidation data and from diffusion data for wustite and magnetite. However, to match with the rate constant calculated from oxidation data, additional information about short-circuit diffusion in hematite is required.

20576 **Stephens and Goldman respond.** Stephens, P.W.; Goldman, A.I. (Department of Physics, State University of New York, Stony Brook, New York 11794). *Physical Review Letters;* **57**: No. 21, 2770-2770(24 Nov 1986).

A respomd to the comment on distinguishing a quasicrystal from an icosahedral glass via lattice imaging is presented. (AIP)

20577 **Nucleation and growth of quasicrystalline Pd—U—Si from the glassy state.** Drehman, A.J.; Pelton, A.R.; Noack, M.A. (Ames Laboratory: USDOE, Iowa State University, Ames, Iowa 50011). *Journal of Materials Research;* **1**: No. 6, 741-745(Nov 1986). Contract W-7405-ENG-82.

A Pd—U—Si metallic glass transforms upon annealing to a quasicrystalline phase of the same composition. Electron diffraction patterns of this material verify its icosahedral symmetry. Differential scanning calorimetry and transmission electron microscopy are used to obtain both the nucleation and growth kinetics of this glass-to-quasicrystal, first-order phase tranformation. The homogeneous nucleation rate of the quasicrystalline phase in the metallic glass achieves a maximum at a temperture where its growth is still relatively slow.

20578 **Crystallization study of the $Ta_{55}$—$Ir_{45}$ amorphous alloy.** Wallace, R.J.; Kaufmann, E.N.; Bell, W.L. (University of California, Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Materials Research;* **1**: No. 6, 758-764(Nov 1986). Contract W-7405-ENG-48.

The crystallization behavior of an arc-melted, splat-quenched amorphous $Ta_{55}$—$Ir_{45}$ alloy was investigated by differential thermal analysis (DTA) and transmission electron microscopy (TEM). The DTA experiments showed that the glass transition temperature (T/sub g/) for this material was 485 °C and that the crystallization temperature (T/sub x/) closely followed at 495 °C. This T/sub x/ is much lower than has been previously reported. In-situ TEM annealing experiments, in addition to confirming T/sub x/, illustrated that crystallization proceeds as a two-step process. A fcc phase is the first to crystallize at 500 °C followed by the equilibrium phases, $\alpha$ and $\sigma$, and/or the bcc Ta phase near 600°—650 °C. Microhardness measurements were made as part of an initial mechanical properties investigation. Inconsistencies with the work of previous investigators of this system are discussed.

20579 **Effects of P implantation on passivity of Fe—Cr alloys in acidic electrolytes.** Sorensen, N.R.; Diegle, R.B.; Picraux, S.T. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Materials Research;* **1**: No. 6, 752-757(Nov 1986). Contract AC04-76DP00789.

The passivation behavior of the P-implanted alloys in a Cl-containing electrolyte as a function of Cr concentration and P implantation has been investigated. At low Cr concentrations (6% Cr), P implantation sufficient to form an amorphous layer degrades the passive behavior of the base alloy and induces pitting, and at high-Cr levels (18%) P has little effect on passivation. However, at intermediate Cr levels (8%, 10%), P implantation significantly improves passivity, with the greatest improvement occurring at 10% Cr. When implanted to —25% P, the Fe—10Cr alloy exhibits a decrease in the passive current density by 4 orders of magnitude relative to the unimplanted alloy, and shows current decay characteristics that closely resemble those of the Fe—18Cr alloy.

20580 **Role of segregated P and S in intergranular stress corrosion cracking of Ni.** Jones, R.H.; Danielson, M.J.; Baer, D.R. (Pacific Northwest Lab., Richland, WA 99352). *Journal of Materials for Energy Systems;* **8**: No. 2, 185-196(Sep 1986). Contract AC06-76RL01830.

The effect of P and S on the intergranular corrosion and stress corrosion of Ni has been evaluated with corrosion tests, crack tip corrosion modeling and stress corrosion tests, and modeling. Tests were conducted in 1 N H/sub 2/SO/sub 4/ at 25°C over anodic potentials of +0.3 V to 2.0 V (SCE). Corrosion tests were conducted on Ni + P and Ni + S alloys and Ni samples ion implanted with P and S. The corrosion results showed that both P and S reduce passivity in Ni and enhance the corrosion rate but that P is oxidized and dissolves in the electrolyte while S remains on the surface. This difference in surface behaviour of P and S was used to explain the difference in intergranular corrosion (IGC) and intergranular stress corrosion cracking (IGSCC) behaviour of Ni + P and Ni + S. The active crevice and crack walls with Ni + S is thought to reduce the concentration gradient and hence the transport of Ni/sup +2/ from tip to mouth which in turn reduces the crack tip corrosion rate. By comparison of the geometry, potential dependence and rates of IGC and IGSCC of Ni + P it was concluded that IGSCC was not controlled solely by anodic dissolution but that a mechanical contribution was involved. Strain assisted corrosion was ruled out while a corrosion assisted intergranular fracture process was shown to be feasible.

20581 **Quantitative metallography as a tool for predicting the impact strength of CF 8M stainless steel.** Morrow, W.D.; Patterson, B.R. (General Test Lab., Alabama Power Co., Birmingham, AL 35291). *Journal of Materials for Energy Systems;* **8**: No. 1, 38-43(Jun 1986).

Charpy impact tests and quantitative metallography were performed on CF 8M stainless steel specimens which had been aged at 750°C for times ranging from 1.2 minutes to 12 hours. Relationships between impact energy and microstructural parameters were explored and it was found that the loss in impact strength during aging was related to the fraction of ferrite-austenite interfacial area covered with intermetallic precipitates. The loss in impact strength was also related to the proportion of ferrite volume transformed.

20582 **TRIBOCOR 532N - A new material for environments involving wear and corrosion.** Ziegler, P.F.; Rausch, J.J. (Fansteel Inc., North Chicago, IL 60064). *Journal of Materials for Energy Systems;* **8**: No. 1, 49-57(Jun 1986).

TRIBOCOR 532/sup */ is an alloy having the composition Nb-30Ti-20W which is produced by the conventional melting techniques used for other refractory metal alloys. The cast alloy is highly fabricable and can be readily formed into various and complex part shapes by cold working, machining, and welding methods. Surface nitriding of the finished shape produces a structure of coherent, hard nitrided phases dispersed in a refractory metal alloy matrix (TRIBOCOR 532N). During nitriding, titanium nitride

forms preferentially and grows as platelets within the grains of the base metal alloy. As the metal matrix adjacent to the platelets becomes depleted in titanium, niobium enters into the reaction, resulting in a final structure of complex nitrides in a niobium-tungsten rich matrix. The reaction produces a surface hardness in excess of low binder content hard metals (e.g., WC-4.5 pct Co). The depth of hardness and the gradient from the surface to the core metal can be varied over considerable limits with different nitriding treatments. The corrosion resistance of TRIBOCOR 532N has been found to be outstanding in a number of different corrosive media, including hydrochloric, nitric, phosphoric, and sulfuric acids, and chloride solutions. The corrosion rates over a wide range of concentrations and temperatures are far less than for common wear grades of cemented tungsten carbide. Excellent resistance to stress corrosion cracking has also been found in tensile and bend test samples evaluated in chloride and alkaline environments.

**20583 Exploratory corrosion tests on alloys in molten salts at 900°C.** Coyle, R.T.; Thomas, T.M.; Lai, G.Y. (Materials Research Branch, Solar Energy Research Institute, Golden, CO 80401). *Journal of Materials for Energy Systems;* 7: No. 4, 345-352(Mar 1986). Contract AC02-83CH10093.

Exploratory corrosion tests were conducted on 16 commercial alloys in carbonate, chloride, and hydroxide molten salts at 900°C for up to three weeks. Corrosion information, including weight change, observations of the coupons, metallographic examination, and evaluation of the corrosion product by SEM, was obtained on the coupons exposed to these salts. These tests indicated that a number of the alloys showed significant resistance to metal loss in the carbonate molten salt with corrosion rates on the order of several millimeters per year. The corrosion product is an interpenetrating structure of metal from the more noble alloy ingredients and of an oxide made up of the reaction between melt components and oxidizable metals from the alloys.

**20584 Ultrasonic backscatter and attenuation in consolidated RSP powder.** Telschow, K.L.; Flinn, J.E. (Idaho National Engineering Lab., EG+G Idaho, Idaho Falls, ID). pp 1355-1364 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

Ultrasonic backscatter and attenuation measurements have been performed on explosively consolidated, rapidly solidified Type 304 stainless steel powder. This material may not be totally metallurgically bonded and the residual particle-like microstructure forms scattering centers for the ultrasonic wave. Results are also reported on specimens that have been annealed at various temperatures. Some mcirostructural changes are observed after annealing; corresponding changes in the backscatter and attenuation are described and the ability of ultrasonic measurements to characterize powder consolidation in these materials is discussed.

**20585 Eddy current nondestructive evaluation of laser glazed metallic surfaces.** Churchill, R.J.; Glass, J.M.; Grogen, H.P.; Lord, W. (American Research Co. of Virginia, Radford, VA). pp 1525-1531 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

The laser glazing process holds great potential in the production of new and improved materials. This paper presents an experimental program in which laser glazing was performed on a number of materials and eddy current NDT techniques were employed to determine defects and changes in properties of laser modified surfaces. A 6KW laser glazing system was used to produce cast iron, steel and nickel alloy specimens whose properties were evaluated using eddy current probe scanning techniques. The results include the evaluation of a wide range of laser glazing conditions, a correlation between glaze depth and eddy current impedance plane phase angle, and flaw detection using split core differential probe designs.

**20586 Microstructural characterization of polycrystalline nickel using magnetic nde methods.** Ranjan, R.; Buck, O.; Thompson, R.B. (Ames Lab., Iowa State Univ., Ames, IA). pp 1335-1344 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This paper presents observations on the variations of magnetic and acoustic Barkhausen noises and the magnetization of plastically deformed pure nickel during different stages of annealing in which a number of microstructural features, such as dislocation density and arrangement, grain size and distribution, change in a well known way. Experimental results indicate that in nickel, non-180 deg domain walls interact more strongly with individual dislocations than 180 deg domain walls. On the other hand, 180 deg domain walls interact more strongly with the dislocation arrangement (as formed during polygonization). The results illustrate the advantages of using multiple magnetic methods to nondestructively evaluate the microstructural conditions of ferromagnetic materials.

**20587 Kramers-kronig relations and the ultrasonic characterization of porosity.** Rose, J.H. (Ames Lab., Iowa State Univ., Ames, IA). pp 1617-1623 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This paper reports on the development of ultrasonic methods to determine the volume fraction of porosity in cast parts, made of A357 aluminum alloy, from the attenuation of longitudinally polarized ultrasound. A model is used to describe the velocity shift and attenuation; KramersKronig relations are established and an equation is derived.

**20588 Gas porosity evaluation in cast aluminum alloys.** Rypien, D.; Adler, L.; Hetzner, D. (Ohio State Univ., Columbus, OH). pp 1625-1632 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

The authors use A357 aluminum alloy in this investigation. With the use of ultrasonic spectroscopy the pore radius and volume percent of porosity in cast aluminum is successfully determined to within 0.1%. Comparison of ultrasonic measurements through other methods included bolume percent measurements by weight and Quantimet surface analysis. The data presented concerns the effect of the as-cast surface on porosity measurements using ultrasonics.

**20589 Evaluation of porosity in aluminum alloy castings by single-sided access ultrasonic backscatter.** Hsu, D.K.; Thompson, D.O. (Ames Lab., Iowa State Univ., Ames, IA). pp 1633-1642 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D O; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

The authors report on a single-side access ultrasonic backscatter method for the aluation of porosity in aluminum alloy casts. Thhis techniq ue makes use of the backscattered signal from the pores and does not require a flat and parallel sample geometry. It is intended for the characterizati of castings where a specular back surface echo is not available due to complex part geometry, excessive thickness, or high porosity content.

**20590 Relative effects of porosity and grain size on ultrasonic wave propagation in iron compacts.** Thompson, R.B.; Gray, T.A.; Spitzig, W.A. (Ames Lab., Iowa State Univ., Ames, IA). pp 1643-1653 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This paper describes work on the evaluation of the potential of ultrasonic measurements to monitor the evolution of porosity. In

polycrystals whose crystallites have low elastic anisotropy, such as aluminum, considerable experimental success has been obtained. However, grain boundary scattering in polycrystals with larger crystallite elastic anisotropy introduces a crystallite background heterogeneity which can lead to errors in those techniques. This paper presents an experimental study of relative contributions on a set of porous iron compacts.

20591 **Ultrasonic analysis of inertia welds.** Armstrong, B.L.; Adler, L.; Baeslack, W.A.; Meng, S. (Ohio State Univ., Columbus, OH). pp 1681-1686 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

Inertia friction welding is a solid state bonding process which allows for the inexpensive joining of otherwise difficult to weld materials. The disadvantage of the process is that little is known about the evaluation of the weld quality. This paper addresses evaluation problems for welds of similar and dissimilar metals. Evaluation was performed by means of ultrasonic signal analysis using spectroscopy, metallographic examination and mechanical testing. Correlations were found between the ultrasonic data, the microstructure and the mechanical test results that would allow for the ultrasonic assessment of the inertia weld quality.

20592 **Absolute acoustoelastic measurements of stress in textured plate with arbitrary stress orientations.** Lee, S.S.; Smith, J.F.; Thompson, R.B. (Ames Lab., Iowa State Univ., Ames, IA). pp 1423-1430 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This paper presents a technique to determine the direction and differences of principal stresses in rolled plates. In three aluminum samples, the effects of texturally induced anisotropy were sufficiently small as to be negligible. In the stainless steel samples examined, the textural anisotropy term was an order of magnitude larger. It is demonstrated that this anisotropy contribution can be removed from the data by a Fourier analysis of the angular dependence of the velocity difference of two orthogonally propagating $SH_0$ waves. The importance of the second order anisotropy in copper is greater still and remains to be studied in detail.

20593 **Ultrasonic characterization of fatigue cracks.** Buck, O.; Rehbein, D.K.; Thompson, R.B. (Ames Lab., Iowa State Univ., Ames, LA). pp 1583-1589 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

Ultrasonic experiments were made to study asperity contactjusing diffraction of bulk or surface waves from locations where the contact occurs. The signal amplitude of shear waves diffracted at each contact point as a function of applied load was measured. The results indicate that the contacts do not open in a perfect sequence. The second method uses mainly the transmission coefficient of bulk waves; the received signal is Fourier analyzed to obtain information on the asperity contact. The basic assumptions of the theory as well as its results are briefly discussed.

20594 **Ultrasonic studies of load induced changes in fatigue crack closure.** Rehbein, D.K.; Buck, O.; Thompson, R.B. (Ames Lab., Iawa State Univ., Ames, IA). pp 1591-1599 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This paper presents ultrasonic studies of the scattering of ultrasonic signals by fatigue cracks and compress the results to predictions of the distributed spring model. Included are the results of loading of the fatigue crack in tension to attempt to force the crack into a more open condition, thereby reducing the number of contact points and the contact stress. A possible method of calculating stiffness from the actual experimental through transmission data is reported; a value can be deduced for the number of contacts present at the faces of the crack.

20595 **Ultrasonic nondestructive evaluation of tube closure welds.** Thomas, G.H.; Spingarn, J.R. (Sandia National Labs., Livermore, CA). pp 1665-1670 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

The authors examine a solid state bond, a tube closure weld, nondestructively. An ultrasonic method has been developed to interrogate the closure weld bondline using custom, 50 megahertz, curve matching transducers and computerized high frequency data acquisition and signal processing equipment. Metallographic analysis was conducted on the welds to better understand the ultrasonic interacition and help select characteristics of the signal for classification of bond quality. A pattern recognition approach to classification netted excellent results for a two class problem of good and bad welds.

20596 **Immersion ultrasonic nde of tubing pinch welds.** Rehbein, D.K.; Hsu, D.K.; Jones, T.A.; Thompson, R.B. (Ames Lab., Iowa State Univ., Ames, IA). pp 1671-1679 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This paper deals with the ultrasonic inspection of tubing pinch welds produced by applying pressure transverse to the tube axis with a pair of cylindrical current pulse. The weld produced consists of a nominally planar bond at equal distance from the resulting concave tube surfaces. The bonds transmission and reflection characteristics may be treated by several recently developed theoretical models for imperfect interfaces.

20597 **Radiation effects encountered by inorganic materials in analytical electron microscopy.** Howitt, D.G. (Univ. of California, Davis, CA). pp 375-392 of Principles of analytical electron microscopy. Joy, D.C.; Goldstein, J.I.; Rourig, A.D. New York, NY; Plenum Press (1986).

An outline of the mechanisms by which elastic and inelastic collisions produce radiation damage in the electron microscope and a brief methodology for making quantitative estimates of each process are given in the first section of this chapter. The other sections are devoted to the estimation of the collection efficiencies for electron energy loss and energy dispersive x-ray spectroscopy and the manner in which radiation damage will affect their reliability. Some quantitative estimates of the significance of radiation damage to analytical electron microscopy are also presented, as well as a brief description of the radiation damage encountered from ion-milling specimen-preparation techniques.

20598 **Reactions at glass-ceramic to metal interfaces.** Loehman, R.E.; Kunz, S.C.; Watkins, R.D. (Sandia National Labs., Albuquerque, NM 87185). pp 721-726 of Proceedings of the 10th annual conference on composites and advanced ceramic materials. Columbus, OH; American Ceramic Society Inc. (1986). (CONF-860152—).

From 10. annual conference on composites and advanced ceramic materials; Cocoa Beach, FL, USA (19 Jan 1986).

Glass-ceramic crystallization can be changed significantly by prior molten glass-metal redox reactions during sealing. The authors measured the interfacial stresses caused by altered crystallization in several glass-ceramic/alloy systems. They identified the redox reactions and determined how the magnitudes of the observed stresses depend on which reactions occur.

**20599 Superconductivity in ternary rare earth transition metal silicides and germanides with the $Sc_5Co_4Si_{10}$-type structure.** Berg, L.S. Ames, IA; Iowa State Univ. (1986). 117p. University Microfilms Order No. 86-27,091.

Thesis (Ph. D.).

A systematic study of the superconducting and normal state properties of some ternary rare earth transition metal silicides and germanides of the $Sc_5Co_4Si_{10}$0-type is reported. Low temperature heat capacity measurements indicate the presence of a complicated phonon density of states in these structurally complex compounds. A better description of the phonon spectrum of the high T/sub c/ materials $Sc_5Rh_4Si_{10}$, $Sc_5Ir_4Si_{10}$, and $Y_5Os_4Ge_{10}$, given by a model proposed by Junod et al., is presented and discussed. The large values of $\Delta C/\gamma$/sub n/T/sub c/ and the electron-phonon coupling constant for these high T/sub c/ compounds indicate that they are strong-coupled superconductors. Relative to other ternary superconductors, many of these materials have large Debye temperatures. DC electrical resistivity measurements on these compounds show resistivity behavior deviating from those exhibited by simple metals. The rho(T) data for $Y_5Ir_4Si_{10}$, $Lu_5Ir_4Si_{10}$, and $Y_5Os_4Ge_{10}$, indicate the presence of anomalies. Static molar magnetic susceptibility measurements performed on these compounds indicate (1) a small effective magnetic moment of 0.26$\mu$/sub B/ on the Co atom and (2) anomalous behaviors in the $Lu_5Rh_4Si_{10}$, $Lu_5Ir_4Si_{10}$, $Y_5Ir_4Si_{10}$, $Lu_5Ir_4Ge_{10}$, and $Y_5Rh_4Ge_{10}$ data. Lastly, upper critical magnetic field measurements were performed on $Sc_5Co_4Si_{10}$, $Sc_5Rh_4Si_{10}$, $Sc_5Ir_4Si_{10}$, $Lu_5Rh_4Si_{10}$, $Lu_5Ir_4Si_{10}$, and $Y_5Os_4Ge_{10}$.

**20600 Ultrasonic response of dilute AlFe alloys irradiated with 2.5-MeV electrons.** Setser, G.G.; Hultman, K.L.; Holder, J.; Granato, A.V. (Univ. of Illinois, Urbana). *Physical Review [Section] B: Condensed Matter;* **32**: No. 3, 1453-1460(1 Aug 1985). Contract AC02-76ER01198.

Ultrasonic attenuation and velocity measurements were made as a function of polarization, temperature, frequency, and annealing before and after 2.5-MeV electron irradiation of dilute AlFe alloys. In addition to the relaxation peaks observed in earlier low-frequency internal-friction measurements, two new relaxation peaks were found. One of these has all the properties predicted by a size-effect model. The peak structure observed is very different from that found for AlMn, suggesting that theories based only on impurity size require extension. 20 references, 12 figures, 3 tables.

**20601 Summary abstract: unoccupied surface states on Cu(100) and Cu(111) studied by inverse photoemission.** Johnson, P.D.; Hulbert, S.L.; Woodruff, D.P.; Stoffel, N.G.; Smith, N.V. (Brookhaven National Lab., Upton, NY). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **3**: No. 3, 1637-1638(May-Jun 1985). Contract AC02-76CH00016.

In this paper they present inverse photoemission spectra recorded from the Cu(111) and Cu(001) surface. To record these data they have used a new electron source and a novel form of photon detector based on the chromatic aberration properties of a LiF lens. This arrangement, described in more detail elsewhere, gives us both improved energy and momentum resolution over their previous experiments. The spectra show both the image potential derived states and the normal crystal potential derived surface states. It is found that the image potential states have different binding energies on the two planes, namely 0.6 eV on the Cu(001) surface and 0.9 eV on the Cu(111) surface.

**20602 Failure analysis and microcrack dependent discontinuum mechanics.** Stout, R.B. (Lawrence Livermore National Lab., Livermore, CA). pp 63-74 of The mechanism of fracture. Goel, V.S. Metals Park, OH; American Society for Metals (1985). (CONF-851203—). Contract W-7405-ENG-48.

From International conference and exhibition on fatigue, corrosion cracking, fracture mechanic and failure analysis; Salt Lake City, UT, USA (2 Dec 1985).

The failure of many materials involves creating dense sets of microcracks. Each microcrack created results in a discontinuity in the deformation between atoms in the material and a change in the thermodynamic energy content of the material. Continuum mechanics does not provide a physical description of the discontinuities nor assign correct internal energy contributions for various thermodynamic processes during microcrack kinetics. In order to represent discontinuities in the deformation and various internal energy contributions during microcrack kinetics, a microcrack dependent discontinuum mechanics has been formulated. This discontinuum mechanics describes a microcrack density function in terms of physical attributes and statistical concepts; represents deformation as a functional to explicitly include interatomic discontinuities from the density of microcrack defects; and models both equilibrium and nonequilibrium thermodynamic processes of microcrack creation, microcrack growth, and microcrack surface energy changes.

**20603 The use of miniaturized tests to predict flow properties and estimate fracture toughness in deformed steel plates.** Haggag, F.M.; Server, W.L.; Lucas, G.E.; Odette, G.R.; Sheckherd, J.W. (EG&G Idaho, Inc.). pp 399-406 of The mechanism of fracture. Goel, V.S. Metals Park, OH; American Society for Metals (1985). (CONF-851203—).

From International conference and exhibition on fatigue, corrosion cracking, fracture mechanic and failure analysis; Salt Lake City, UT, USA (2 Dec 1985).

Prediction of failure in a structure requires knowledge of the mechanical properties of the materials involved. In the case of serious accidents, such as derailments of railroad tank cars carrying hazardous materials, prediction of failure in damaged components is impeded by difficulties in determining the deformed material fracture toughness, the cracks induced by the accident, and the stress state in the damaged region. This paper addresses the problem of determining fracture toughness. Miniaturized shear punch tests on virgin, strained, and deformed steel plates (typical of railroad tank car construction) were conducted over a wide range of test temperatures. These data were compared with tensile measurements on identical materials. The use of these data coupled with micro-mechanical models of fracture allows estimation of the deformed material fracture toughness. Comparisons of the predicted fracture toughness with actual measurements are made.

**20604 Estimation of the C intregral for creep-crack-growth test specimens.** Jaske, C.E. (Battelle's Columbus Div., Columbus, OH). pp 577-586 of The mechanism of fracture. Goel, V.S. Metals Park, OH; American Society for Metals (1985). (CONF-851203—).

From International conference and exhibition on fatigue, corrosion cracking, fracture mechanic and failure analysis; Salt Lake City, UT, USA (2 Dec 1985).

The C integral is a useful parameter for characterizing creep-crack-growth results. To develop creep-crack-growth rate data as a function of C, one must be able to calculate estimates of C for commonly used fracture-mechanics specimen configurations. Following past work in developing procedures for estimating values of the J integral, simplified procedures for estimating values of C were developed. These procedures then were applied to develop estimates of C for five specimen configurations: (1) compact-type (CT), (2) center-cracked tension (CCT), (3) three-point bend (TPB), (4) low-cycle fatigue (LCF), and (5) edge-notch tension (ENT). For the first three specimen configurations, long cracks greater than approximately one-half way through the specimen section were considered.

**20605 Grain boundary structure effects on creep cavitation susceptibility.** Zhao, J.; Adams, B.L. (Brigham Young Univ., Provo, UT). pp 597-604 of The mechanism of fracture. Goel, V.S. Metals Park, OH; American Society for Metals (1985). (CONF-851203—).

From International conference and exhibition on fatigue, corrosion cracking, fracture mechanic and failure analysis; Salt Lake City, UT, USA (2 Dec 1985).

Grain boundary structure plays a very important role in creep cavitation. A function called the misorientation distribution function (MDF) defined in Euler space has been used to statistically characterize the boundary structure of polycrystalline materials. The theoretical development of the MDF is presented. Experimental results showed that $\Sigma 3$ and $\Sigma 9$ special boundaries occur with high frequency in 304 stainless steel and the data also suggested a possible directional dependence of the grain boundary structure.

20606 **New observation of two-hole core-level satellites in copper, silver, and gold.** Martensson, N.; Nyholm, R.; Johansson, B. (Linkoeping Univ., Sweden). *Physical Review [Section] B: Condensed Matter;* **29**: No. 8, 4800-4802(15 Apr 1984).

The experimental core-level spectra for the noble metals Cu, Ag, and Au are shown to contain intrinsic satellite features. In the case of Ag, however, the identification is somewhat less certain than for the other two metals. The satellites are interpreted as being due to d-valence-electron shakeup processes. This view is supported by calculations of the multiplet splittings and also by calculations of the energy separation between the satellite and the main line. 23 references, 3 figures.

20607 **Summary abstract: autoionization emission from transition metals: an electron stimulated analog of resonant photoemission.** Zajac, G.; Bader, S.D.; Zak, J. (Argonne National Lab., IL). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **2**: No. 2, 933-934(Apr-Jun 1984).

Previous work in 3d transition metals has identified autoionization emission associated with direct recombination of the resonant $3p \rightarrow 3d$ transition. This autoionization emission has been examined for all the 3d transition metal elements from Sc to Cu. Two important trends with atomic number Z are observed which correlate with those previously reported in the 3p core-level electron loss spectra. First, the intensity of this emission decreases with increasing Z. Second, the separation of the emission peak from the 3p threshold is large ($\sim$ 10 eV) toward the beginning of the series (Sc through Cr) and abruptly drops to a few electron volts near the middle of the series (Mn and Fe).

20608 **Summary abstract: kinetics of antiphase domains coarsening in an overlayer.** Wang, G.C.; Lu, T.M. (Oak Ridge National Lab., TN). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **2**: No. 2, 1048(Apr-Jun 1984).

The authors have used low energy electron diffraction (LEED) to study the kinetics of ordering of oxygen chemisorbed on a W(112) surface at a half-monolayer (0.5 ML) coverage. When a submonolayer of oxygen was adsorbed on the surface at room temperature, a p(2 x 1) LEED pattern was observed. Both the clean and oxygen covered surfaces are (1 x 1) reconstructed as determined by a comparison between the measured intensity-energy (I-V) profiles and dynamical LEED calculations. The p(2 x 1) structure allows two possible antiphase domains. Thus, the ground state of the p(2 x 1) structure is two fold degenerate ($p = 2$).

20609 **Characterization of creep damage in metals using small angle neutron scattering.** Fuller, E.R. Jr.; Fields, R.J.; Chuang, T.J.; Singhal, S. (National Bureau of Standards, Washington, DC). *Journal of Research of the National Bureau of Standards (United States);* **89**: No. 1, 35-45(Jan-Feb 1984). Contract FG02-84ER45088.

Creep damages in polycrystalline metallic materials can be attributed to cavitation and cracking along the grain interfaces. Theories of creep cavitation that have been developed in recent years are reviewed. Further evaluation and/or refinement of these theories has been retarded by a lack of an experimental counterpart. Small angle neutron scattering studies (SANS) provide one experimental tool which is complementary to others. SANS done at NBS and elsewhere have shown that this technique is suitable for studying nucleation and early stage of growth of creep cavities. This would provide the impetus to further progress in this area. 32 references, 8 figures, 2 tables.

20610 **Modelling the behavior of materials.** Wilkins, M.L. (Univ. of California, Lawrence Livermore National Lab., Livermore, CA 94550). pp 243-277 of Structural impact and crashworthiness. Volume 2. Morton, J. New York, NY; Elsevier Science Pub. Co. Inc. (1984). (CONF-840717—). Contract W-7405-ENG-48.

From Hazardous waste management; Boston, MA, USA (16 Jul 1984).

The first requirement in the calculation of problems in mechanics is a formulation of the material behavior. The material description should include elastic, elastic-plastic, and hydrodynamic flow. Appropriate yield criteria must be employed. Literature includes many complicated forms to describe material behavior, some of which have been developed to aid the mathematics in the analytic solution of the equation of motion. However, since numerical techniques are considered here, the equations of motion are completely independent of equations that describe material behavior, and any mathematical form may be used. The objective of the material models is to provide a theoretical description applicable to a wide class of practical problems, but using simple idealizations of the outstanding features of the real phenomenon. The problems of greatest present interest pertain to metal plasticity. Therefore, details for describing elastic-plastic material are presented. The formulation of this problem provides the framework for more sophisticated descriptions of material behavior. The mathematics has been organized so that a departure can be made from the elastic perfectly plastic model without any change to the basic program that solves the equations of mechanics. Some of the material descriptions presented include dynamic yielding based on dislocation theory, work hardening, pressure, and temperature effects on material strength. Incremental plasticity is used so that large deformations with rotation are modeled.

20611 **Influence of texture on the interpretation of diffraction data to determine residual stress.** MacEwen, S.R.; Faber, J. Jr.; Turner, A.P.L. (Atomic Energy of Canada Ltd., Chalk River, Ontario). *Scripta Metallurgica;* **18**: No. 6, 629-633(1984).

In their letter, Noyan and Cohen (NC) raise several questions that they claim must be answered before the interpretation and conclusions of their recent paper can be justified. Specifically, NC are concerned with the effects of the rapidly-varying and slowly-varying stresses that arise in materials containing hard and soft regions, the choice of elastic constants required to convert measured strains to stresses, and the influence of crystallographic texture. The conclusion of the NC letter is that only in the absence of preferred orientation can the results of neutron diffraction experiments, when a large volume is sampled, be interpreted to give a meaningful determination of residual stress. In their reply, they will discuss the effects of strain gradients on diffraction patterns and will show that, contrary to the conclusion of NC, the uncertainties introduced by the presence of inhomogeneous interaction stresses and anisotropic elastic constants are reduced in a material that contains strong preferred orientation.

20612 **Purification of zirconium by electrotransport processing.** Zee, R.H.; Carpenter, G.J.C.; Schmidt, F.A. (Atomic Energy of Canada Ltd., Chalk River, Ontario). *Scripta Metallurgica;* **18**: No. 5, 489-493(1984). Contract W-7405-ENG-82.

To better understand what effects solutes have on the true intrinsic properties of zirconium, it is imperative to first prepare metal of extreme purity. This is of particular importance in their present studies concerning the effects of irradiation on the properties of creep and growth in zirconium. One of the most effective methods of preparing high purity metals is by electrotransport processing at high temperatures. In 1940, DeBoer and Fast reported that oxygen migrated toward the anode in zirconium when a dc current is passed through it at elevated temperatures. This was further substantiated by Claudson. Schmidt et al. measured the electric mobility, diffusivity and effect valence of carbon, nitrogen and oxygen in beta zirconium over the temperature range of 1900 K to 2075 K. It was the purpose of this study to utilize these previously determined electrotransport parameters and high vacuum technology to prepare a small amount of ultrapure zirconium for use in irradiation studies at the Chalk River Nuclear Laboratories.

20613 **Thermal expansion coefficient determination by CBED.** Angelini, P.; Bentley, J. (Oak Ridge National Lab., TN). pp 93-96 of Analytical electron microscopy - 1984. Williams, D.B.; Joy, D.C. (eds.). San Francisco, CA; San Francisco Press, Inc. (1984). Contract AC05-84OR21400.

The present application of CBED involves measurements of thermal-expansion coefficients by measurement of changes in HOLZ line positions as a function of temperature. Previous work

on this subject was performed on Si at a constant accelerating voltage of 100 kV between about 90 and 600 K. Diffraction patterns were recorded and line shifts correlated to lattice parameter changes. Differences were noted between values determined by CBED and accepted thermal expansion values. Significant HOLZ line interactions and splitting occurring in the (111) patterns were noted to contribute to the differences. Preliminary measurements have been made on Al, $Al_2O_3$, and single-crystal tau (Ni/sub 20.3/Ti/sub 2.7/$B_6$). An example of changes in HOLZ lines present in (114) patterns for Al are shown and the effect of temperature on the position of lines in the pattern illustrated.

20614 **EDS round-robin evaluation of type 308 austenitic stainless steel.** Vitek, J.M. (Oak Ridge National Lab., TN). pp 373-376 of Analytical Electron Microscopy. Williams, D.B.; Joy, D.C. (eds.). San Francisco, CA; San Francisco Press, Inc. (1984). Contract AC05-84OR21400.

Compositional analysis based on transmission electron microscopy and EDS detectors has made significant advances in the last decade, with regard to both equipment available and data-analysis procedures. Concentrations determined by this technique are commonly quoted in the literature. However, a large variety of hardware and software is available at present and standard procedures for specimen preparation, data acquisition, and data reduction have not been established. Therefore, detailed comparisons of results from different sources may not be very accurate. The purpose of this investigation was to evaluate the variations that may exist in compositional evaluations performed by different investigators using different equipment. A round-robin analysis of identical specimens was initiated and the results are reported here.

20615 **Theory of ferro-magnetism of transition metals at finite temperatures.** Gyorffy, B.L.; Kollar, J.; Pindor, A.J.; Stocks, G.M.; Staunton, J.; Winter, H. (Univ. of Bristol, England). pp 593-656 of Electronic structure of complex systems. Phariseau, P.; Temmerman, W.M. (eds.). New York, NY; Plenum Publishing Corporation (1984).

The nature and origin of magnetic order in metals is one of the most elusive problems in solid state physics. Fifty years after the pioneering work of Block (1929), Mott (1935), Stoner (1936) and Slater (1936) it is still not as well understood as the apparently more esoteric phenomenon of superconductivity (Parks 1969). While this subject has never lacked devotees at the moment they are witnessing a particularly active period due to the fact that recent progress seems to have brought the possibility of a fairly complete microscopic quantitative theory within sight. The purpose of these lectures is to sketch the outlines of the emerging picture and the prospects for doing realistic first principles calculation for metallic magnets at finite temperatures.

20616 **Remarkable surface structure sensitivity of the ammonia synthesis over rhenium single crystals.** Asscher, M.; Somorjai, G.A. (Lawrence Berkeley Lab., CA). *Surface Science;* **143**: L389-L392(1984). Contract AC03-76SF00098.

In this letter they report the first ammonia synthesis study over rhenium single crystal surfaces, under pressure conditions approaching those used industrially (20 atm). They found an unprecedented structure sensitivity for this reaction on different faces: the Re(0001) basal plane is practically inactive, within their detection limits, while the open Re(1120) crystal plane was found to be more active than the most active iron single crystal surface. The Re(1010) surface was studied as well and found to be only slightly active. The activity ratio at a crystal temperature of 870 K being 1:50:1700 for the Re(0001), Re(1010) and the Re(1120) planes respectively. The very small detectable activity of the Re(0001) probably arises from the crystal edges. The activation energies for the $NH_3$ synthesis on both the Re(1120) and the polycrystalline foil were found to be the same, e.g., 20 +/- 1 kcal/mol, which is very close to the value found on the Fe(111) crystal, e.g., 19.4 kcal/mol [3].

20617 **Ion-beam-mixing in metal-metal systems and metal-silicon systems.** Hung, L. Ithaca, NY; Cornell Univ. (1984). 175p. University Microfilms Order No. 84-07,418.

Thesis (Ph.D.).

The influence of energetic ion bombardment on the composition and structure of thin film materials and utilization of ion-beam-mixing techniques to modify interfacial reactions are reported in this thesis. The phase formation in metals by using ion mixing techniques has been studied. Upon ion irradiation of Al/Pt, Al/Pd and Al/Ni thin films, only the simplest intermetallic compounds of PdAl and NiAl were formed in crystalline structure, while the amorphous phase has been observed over a large range of composition. Ion mixing of Au/Cu bilayers resulted in the formation of substitutional solid solutions with no trace of ordered compounds. The formation of the ordered compound CuAu was achieved either by irradiation of bilayers with Ar ions at elevated substrate temperature or by irradiation of the mixed layers with He ions at relatively low temperature. In the Au/Al system several crystal compounds existed in the as-deposited samples. These phases remained crystalline or transformed into other equilibrium compounds upon ion irradiation. The results suggest that the phase formation by ion mixing is dependent on the high quench rate in the collision cascade region and the atomic mobility at the irradiation temperature. The argument can be applied to silicide forming systems. With near-noble metals, the mixed atoms are mobile and form metallurgically distinct phases. With refractory metals, amorphous phases are formed due to lack of atomic mobility.

20618 **Point defect supersaturation and enhanced diffusion in SPE regrown silicon.** Pennycook, S.; Narayan, J.; Holland, O.W. (Oak Ridge National Lab., TN). *Materials Research Society Symposia Proceedings;* **27**: 293-298(1984). Contract W-7405-ENG-26.

Transient, greatly enhanced diffusion has been observed on annealing solid-phase-epitaxial (SPE) grown Si-Sb alloys. This is shown to be due to a high concentration of interstitials being trapped during SPE regrowth. The migration enthalpy, for diffusion of Sb by an interstitialcy mechanism was measured as 1.8 +/- 0.2 eV. The interstitials eventually condensed into loops, marking the end of the transient. In a SPE grown Si-Bi alloy a similar transient enhanced diffusion was observed, with an activation energy of 2.0 +/- 0.2 eV, but no loops formed. 8 figures, 7 references.

20619 **Numerical study using front tracking finite elements on the morphological stability of a planar interface during transient solidification processes.** Tsai, H.L.; Rubinsky, B. (Lawrence Berkeley Lab., CA). *Journal of Crystal Growth;* **69**: 29-46(1984). Contract AC03-76SF00098.

A new numerical method using front tracking finite elements was developed for the solution of multidimensional transient heat and mass transfer diffusion equations during solidification processes in binary alloys or solutions. The method can cope with irregular geometrical morphologies. The use of this method was demonstrated in a study on the effects of transient, short time, temperature fluctuations on the morphology of a planar solid-liquid interface during a transient solidification process. The numerical studies performed for situations in which the solute in front of the interface was thermodynamically supercooled indicate that the short time temperature perturbations cannot alter the planar morphology of the interface. An explanation of this result was presented in terms of the transient heat and mass transfer processes during solidification. 26 references, 13 figures, 1 table.

20620 **Sputtering and compositional changes.** Wiedersich, H. (Argonne National Lab., IL). pp 261-285 of Surface modification and alloying. Poate, J.M.; Foti, G.; Jacobson, D.C. (eds.). New York, NY; Plenum Publishing Corporation (1983).

A good qualitative and partially quantitative understanding exists for most of the individual processes involved in sputtering. However, systematic investigations of alloy sputtering that consider all of these processes and their potential interactions have not been attempted. The purpose of the following discussion is to characterize the process in simple physical terms and to point out under what conditions they may become important for compositional changes in near-surface regions of sputtered alloys. In Section III, results of recent model calculations are presented which indicate the effects to be expected from the five major processes. The discussion will be limited to metallic alloys where ionization processes are unimportant for defect production and sputtering. The emphasis

is placed here on compositional changes of the target, which are related to the composition of the integrated sputtered flux.

**20621 Iterated three-layer model of the double layer with permanent dipoles.** MacDonald, J.R.; Liu, S.H. (Univ. of North Carolina, Chapel Hill). *Surface Science;* **125**: 653-678(1983). Contract W-7405-ENG-26.

There does not exist a theory of the ionic double layer at a completely blocking metal electrode in liquid electrolytes which is adequate in the charge/potential region where ions and solvent molecules begin to approach saturated conditions. Under these conditions, the continuum theory, such as that of Gouy and Chapman (GC), becomes entirely inadequate. Here the problem is attacked in a semi-discrete way by first partitioning the space charge region into layers parallel to the planar blocking electrode. Each layer is part of a cubic lattice with lattice-site spacing determined by the pure solvent concentration. Lattice sites may be occupied by ions of either sign or by solvent molecules, taken as spheres having a permanent dipole moment. The solvent molecule finite-length dipoles are then approximated by slabs of constant point-dipole polarization. Thus each of the planes parallel to the electrode is a locus of ion centers, and the polarization is accounted for by equal and opposite charge layers equidistant on either side of an ionic charge layer. The mean polarization and ionic concentration in each three-layer region are determined self-consistently by free energy minimization, and electrostatic equations are employed to couple the electrical conditions in one layer to those adjacent. This ion-dipole model (IDM) is solved self-consistently for arbitrary molarity in two regimes: the weak-field situation where the electrode charge approaches zero, and the arbitrary field-strength regime. A simpler model, more directly appropriate for single crystals than for liquids, the layered lattice gas model (LLM), retains layering but represents the permanent dipolar polarization by a non-saturable continuum bulk dielectric constant; it is thus intermediate between the IDM and the GCM.

**20622 Scattering of phonons by dislocations.** Anderson, A.C. (Univ. of Illinois, Urbana). pp 237-262 of Dislocations in solids. Nabarro, F.R.N. (ed.). Amsterdam, Netherlands; North-Holland Publishing Company (1983). Contract AC02-76ER01198.

By 1950, an explicit effort had been launched to use lattice thermal conductivity measurements in the investigation of defect structures in solids. This technique has been highly successful, especially when combined with the measurements of other properties such as optical absorption. One exception has been the study of dislocations. Although dislocations have a profound effect on the phonon thermal conductivity, the mechanisms of the phonon-dislocation interaction are poorly understood. The most basic questions are still debated in the literature. It therefore is pointless to attempt a quantitative comparison between an extensive accumulation of experimental data on the one hand, and the numerous theoretical models on the other. Instead, this chapter will attempt to glean a few qualitative conclusions from the existing experimental data. These results will then be compared with two general models which incorporate, in a qualitative manner, most of the proposed theories of the phonon-dislocation interaction. It may well be asked, if the thermal-conductivity technique is so nondefinitive, why is it used? The answer is simple. Until very recently, measurement of thermal conductivity was the only means available to probe the interaction between phonons and defects at phonon frequencies above the standard ultrasonic range of about $10^9$ Hz. The following introductory paragraphs provide a brief review of the thermal-conductivity technique and the problems which are encountered in practice. There is also a brief presentation of the theoretical models and the complications that may occur in more realistic situations. These introductory paragraphs are included so that the reader may better understand why so little information has been derived from so much effort.

**20623 Thermal properties of metallic sodium near melt from molecular dynamics calculation.** Straub, G.K.; Swanson, R.E.; Holian, B.L.; Wallace, D.C. (Los Alamos National Lab., NM). pp 137-149 of Ab initio calculation of phonon spectra. Devreese, J.T. (ed.). New York, NY; Plenum Publishing Corporation (1983).

Molecular dynamics simulations of the thermal properties of metallic sodium were performed in the high temperature anharmonic region near the melting point. The ion-ion interaction potential was derived from pseudopotential theory. From the molecular dynamics results, the anharmonic thermal energy was determined directly without the use of thermodynamic perturbation theory. Comparison of the calculated melting temperature, latent heat of fusion, fluid phase diffusion coefficient, and the atomic distribution function are all in good agreement with experiment. 9 references, 9 figures, 1 table.

## 3602 Ceramics, Cermets, And Refractories

*REFER ALSO TO CITATION(S) 20056, 20161, 20520, 20541, 20565, 20598, 20613, 20880, 20881, 20881, 20881, 20882, 20882, 20883, 20883, 20883, 20884, 20884, 20884, 20885, 20885, 20885, 20916, 21456, 21758, 21965, 22043*

**20624 (AD-A—175446/4/XAB) Phase diagrams of cubic systems under uniaxial quadratic symmetry-breaking fields.** Caflisch, R.G.; Blankschtein, D. (Massachusetts Inst. of Tech., Cambridge (USA). Research Lab. of Electronics). 1 Jul 1986. 12p. NTIS, PC A02/MF A01.

Published in Physical Review B, Vol. 34, No. 1, 250-260(1 Jul 1986).

The effect of uniaxial quadratic symmetry-breaking fields on two- and three-component systems that possess cubic symmetry is studied. A Landau free-energy, which includes sixth order terms in the order parameter is constructed and analyzed in the context of mean-field theory. A remarkably rich spectrum of complex phase diagrams featuring several ordered phases is predicted. The phase diagrams exhibit a variety of multicritical points including triple, bicritical, tetracritical, tricritical, and critical-end points. We also predict the existence of two consecutive tricritical points along phase boundaries separating ordered phases. Some of these phase diagrams may be realized in certain compounds corresponding to two- and three-component cubic systems such as $Tb_2(MoO_4)_3$ and $BaTiO_3$.

**20625 (AD-A—175520/6/XAB) Paramagnetic defect centers of $SiO_2$-$GeO_2$ gels and gel glasses.** Kordas, G.; Mukherjee, S.P. (Vanderbilt Univ., Nashville, TN (USA)). 1986. 6p. NTIS, PC A02/MF A01.

Published in J. of Non-Crystalline Solids, Vol. 82, 160-164(1986).

Gamma-ray-induced paramagnetic centers were detected at 9.5 GHz and 300 K in supercritically dried 94 $SiO_2$-6 $GeO_2$ gels after heat treatment at 462 C. The ESR spectrum of the gel consisted of a narrow and an asymmetric line. The asymmetric line was attributed to the Ge-E usb 1-center. The defect center generating the narrow line was not identified. The supercritically dried gels after heat treatment (T/sub H/) at 1000, 1150, and 1280 C were also exposed to gamma irradiation. In the gel with T/sub H/ = 1150 and 1280 C, the signal of the Ge (1)-defect center was dominated by the ESR spectra of these samples. The Ge(1)-defect center was described by an electron trapped by a germanium atom co-ordinated through bridging oxygens to two silicon and one germanium atoms.

**20626 (AD-A—175559/4/XAB) Effects of annealing of the $GeO_2$ glasses on their paramagnetic center concentration.** Kordas, G.; Weeks, R.A. (Vanderbilt Univ., Nashville, TN (USA)). 1986. 8p. NTIS, PC A02/MF A01.

Published in International Congress on Glass, Vol. 14, 17-23(1986).

Paramagnetic resonance spectra of $GeO_2$-glasses were measured at 9 GHz and temperatures from 100 to 300 K as a function of T/sub phi/ and annealing time. T/sub phi/, the temperature at which the glass melt was equilibrated, was chosen to be 1450, 1550, and 1650 C, and the annealing temperature was 420 C. The concentration of the $E_1$-center, measured in the as produced glass was least in the 1550 C glass. Paramagnetic centers were not detected in any of the samples after annealing for about 15 minutes. The $E_1$-and a new defect center were detected after 20-min annealing treatments. The total concentration of the paramagnetic states after 30 minutes of treatments is highest in the 1550 C glass. With further

annealing the paramagnetic center concentration decreases, reaching an equilibrium value after 31 hours. The total paramagnetic defect center concentration in the glasses annealed for 31 hours before and after irradiation exhibits the same pattern with respect to T/sub phi/ as the E/sub i/-concentration dependence on T/sub phi/ obtained in the as produced $GeO_2$ glasses before and after irradiation, respectively. Although the defect-center concentration decreased by annealing the glasses, their structure manifested by T/sub phi/ is maintained.

**20627 (AD-A—175570/1/XAB) Nature of the paramagnetic states in $SiO_2$-$GeO_2$-sol-gel glasses.** Kordas, G.; Murkherjee, S.P. (Vanderbilt Univ., Nashville, TN (USA). Dept. of Mechanical and Materials Engineering). 1986. 20p. NTIS, PC A02/MF A01.

Published in Proceedings of the Materiels Research Society Symposium, Vol. 61, 413-417(1986).

The 9.5-GHz ESR spectra of gamma-ray-irradiated 94 $SiO_2$-6 $GeO_2$ (mo1%) aero gel heat treated at 462 C were recorded at 300 K. The ESR spectrum of this gel consisted of an asymmetric line attributed to the Ge(3)-center and other components not yet identified. The 94 $SiO_2$-6 $GeO_2$ gel was treated at 1000 and 1280 C and then exposed to gamma radiation. The Ge(1)- and Ge(3)-centers were identified in the 94 $SiO_2$ gel with T/sub H/ = 1000 C. At T/sub H/ = 1280 C, the signal of the Ge(1)-center dominated the spectrum of this sample. The spectra of the 58 $SiO_2$-42 $GeO_2$ gels with T/sub H/ = 1200 and 1400 C can be described by the Ge(3)-center. The Ge(1)-center was of minor importance in these samples.

**20628 (CETIM—2-F-362) Ionic deposits. Final report.** Peyre, J.P.; Rohart, F.; Segura, N.; Tournier, C. (Centre Technique des Industries Mecaniques, Senlis (France)). Oct 1985. 264p. (In French). (ETN—86-98452). NTIS, PC A12/MF A01.

The mechanical characteristics of TiN and TiC coatings made using the vapor phase deposit technique are investigated. A reactor to obtain the coatings was developed. The spectroscopic analysis of the reactor plasma gives valuable indications about the reaction parameters. Metallurgical analyses were carried out using several techniques, including electron microscopy and radio crystallography. Acoustic emission methods were employed to measure the ductility of the coatings. The measured characteristics are discussed and applications are suggested.

**20629 (CONF-861258—1) Thermal expansion of epoxy-fiberglass composite specimens.** McElroy, D.L.; Weaver, F.J.; Bridgman, C. (Oak Ridge National Lab., TN (USA); Grumman Corp., Bethpage, NY (USA). Space Systems Div.). 1986. Contract AC05-84OR21400. 30p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87004273.

From 9. international thermal expansion symposium; Pittsburgh, PA, USA (8 Dec 1986).

The thermal expansion behavior of three epoxy-fiberglass composite specimens was measured from 20 to 120°C (70 to 250°F) using a fused quartz push-rod dilatometer. Billets produced by vacuum impregnating layers of two types of fiberglass cloth with an epoxy resin were core-drilled to produce cylindrical specimens. These were used to study expansion perpendicular and parallel to the fiberglass layers. The dilatometer is held at a preselected temperature until steady-state is indicated by stable length and temperature data. Before testing the composite specimens, a reliability check of the dilatometer was performed using a copper secondary standard. This indicated thermal expansion coefficient ($\alpha$) values within +-2% of expected values from 20 to 200°C.

**20630 (CONF-870254—2) Synthesis of alumina-zirconia powders by sol-gel processing.** Bond, W.D.; Becher, P.F. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005721.

From 3. international conference on ultrastructure processing of ceramics, glasses, and composites; San Diego, CA, USA (23 Feb 1987).

The object of this investigation is to determine the feasibility of sol-gel processes for preparing powders of phase-stabilized zirconia. Composites of phase-stabilized zirconia and alumina in which fracture toughening is achieved by the tetragonal to monoclinic transition in $ZrO_2$ are one of the promising candidate materials for advanced heat engine applications. To achieve superior strength in these composites, structural considerations dictate that the composites be uniform in composition, passes fine-grained microstructures and be highly dense. Sol-gel processes have the potential for the synthesis of powders from which these composites can be fabricated. Yttrium oxide in concentration of 0.5 to 5 mole % (zirconia basis) was used for phase stabilization of zirconia. In the present study particular emphasis was placed on determining the process parameters which control the homogeneity of $Y_2O_3$ in the zirconia phase. The stress required to transform tetragonal $ZrO_2$ during fracture is a function of $Y_2O_3$ content. It is well established that gel composition and properties are controlled by the chemistry and processing conditions employed in the individual steps of sol-gel processes. The present study was concerned with the preparation of gel powders of $Al_2O_3$ - ($ZrO_2$ . $Y_2O_3$) from precursor aqueous sols containing the codispersed colloidal oxides. Variables studies included: (1) the pH of the sols from which gelation was effected, (2) the rate of gelation, and (3) the method of synthesizing the colloidal oxides for dispersion as sols. 8 refs., 6 figs.

**20631 (DOE/ER—0314) Basic research in ceramic and semiconductor science at selected Japanese laboratories: Based on a September 1986 visit: Highlights, Summary and overview, Detailed notes from selected Japanese laboratories.** (USDOE Office of Energy Research, Washington, DC. Office of Basic Energy Sciences). Mar 1987. 105p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87006596.

In order to better understand Japanese research to develop viable technological ceramics and compound semiconductors and the requisite capability to reliably manufacture these materials, I visited three national laboratories, four universities, and three companies that are involved with such efforts. I also participated in the 3rd International Conference on the Science and Technology of Zirconia.

**20632 (EFI—741(56)-84) On some peculiarities of electron emission from low-density dielectrics irradiated by $\alpha$-particles and relativistic electrons.** (Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike, Moscow (USSR)). 1984. 20p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700858.

Ratios of electron emission coefficients and their fluctuations for the controllable secondary electron emission at irradiation of low-density dielectric layers of KBr and MgO by $\alpha$-particles of Esub($\alpha$) approximately equal to 5.5 MeV and $\beta$-particles of Esub($\beta$) approximately equal to 0.5-2.2 MeV are measured. A disproportion is found in these ratios, and reasons for its origin are discussed. 14 refs.; 6 figs.

**20633 (FEI—1741) Study of niobium-oxygen and vanadium-nitrogen solid solutions using slow neutron scattering technique.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1985. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700872.

The results of inelastic scattering spectra measurements of NbOsub(0.03) and VNsub(0.05) slow neutrons are presented in the paper. In the matrix atoms vibration region in solid solutions spectra as compared with initial metals the spectrum features broadening and boundary frequency drift towards high frequencies is observed. Oxygen atom vibrations in niobium correspond to the bands with epsilonsub(1.2) = 47 +- 1 meV and epsilon/sub 3/ approximately 61 meV (band width $\Delta$epsilonsub(1.2) is equal 6.2 +- 1.0 meV). Vibration frequencies of nitrogen atoms in vanadium constitute epsilonsub(1.2) = 70 +- 1 meV, epsilon/sub 3/ 92 +- 2 meV. The bands width in VNsub(0.05) as well as in VOsub(x) phases are rather large and constitute ($\Delta$epsilon/epsilon)sub(1.2) appoximately 0.2; ($\Delta$epsilon/epsilon)/sub 3/ approximately 0.28. 12 refs.; 3 figs.

**20634 (N—87-13539) Thermal barrier coating life prediction model. Annual report.** Hillery, R.V.; Pilsner, B.H.; Cook, T.S.; Kim, K.S. (General Electric Co., Cincinnati, OH (USA)). Apr 1986. 129p. (NASA-CR—179504; NAS—1.26:179504; R—86AEB511; AR—2). NTIS, PC A07/MF A01.

This is the second annual report of the first 3-year phase of a 2-phase, 5-year program. The objectives of the first phase are to determine the predominant modes of degradation of a plasma sprayed thermal barrier coating system and to develop and verify life prediction models accounting for these degradation modes. The primary TBC system consists of an air plasma sprayed $ZnO_2$-$Y_2O_3$ top coat, a low pressure plasma sprayed NiCrAlY bond coat, and a Rene' 80 substrate. Task I was to evaluate TBC failure mechanisms. Both bond coat oxidation and bond coat creep have been identified as contributors to TBC failure. Key property determinations have also been made for the bond coat and the top coat, including tensile strength, Poisson's ratio, dynamic modulus, and coefficient of thermal expansion. Task II is to develop TBC life prediction models for the predominant failure modes. These models will be developed based on the results of thermmechanical experiments and finite element analysis. The thermomechanical experiments have been defined and testing initiated. Finite element models have also been developed to handle TBCs and are being utilized to evaluate different TBC failure regimes.

**20635 (N—87-13540) Thermal barrier coating life prediction model. Annual report.** Hillery, R.V.; Pilsner, B.H. (General Electric Co., Cincinnati, OH (USA)). Apr 1985. 74p. (NASA-CR—175010; NAS—1.26:175010; R—85AEB304; AR—1). NTIS, PC A04/MF A01.

This is the first report of the first phase of a 3-year program. Its objectives are to determine the predominant modes of degradation of a plasma sprayed thermal barrier coating system, then to develop and verify life prediction models accounting for these degradation modes. The first task (Task I) is to determine the major failure mechanisms. Presently, bond coat oxidation and bond coat creep are being evaluated as potential TBC failure mechanisms. The baseline TBC system consists of an air plasma sprayed $ZrO_2$-$Y_2O_3$ top coat, a low pressure plasma sprayed NiCrAlY bond coat, and a Rene'80 substrate. Pre-exposures in air and argon combined with thermal cycle tests in air and argon are being utilized to evaluate bond coat oxidation as a failure mechanism. Unexpectedly, the specimens pre-exposed in argon failed before the specimens pre-exposed in air in subsequent thermal cycles testing in air. Four bond coats with different creep strengths are being utilized to evaluate the effect of bond coat creep on TBC degradation. These bond coats received an aluminide overcoat prior to application of the top coat to reduce the differences in bond coat oxidation behavior. Thermal cycle testing has been initiated. Methods have been selected for measuring tensile strength, Poisson's ratio, dynamic modulus and coefficient of thermal expansion both of the bond coat and top coat layers.

**20636 (N—87-14518) High-temperature effect of hydrogen on sintered alpha-silicon carbide.** Hallum, G.W.; Herbell, T.P. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1986. 25p. (NASA-TM—88819; E—3180; NAS—1.15:88819; CONF-860418—23). NTIS, PC A02/MF A01.

From 88. annual meeting of the American Ceramic Society; Chicago, IL, USA (27 Apr 1986).

Sintered alpha-silicon carbide was exposed to pure, dry hydrogen at high temperatures for times up to 500 hr. Weight loss and corrosion were seen after 50 hr at temperatures as low as 1000 C. Corrosion of SiC by hydrogen produced grain boundary deterioration at 1100 C and a mixture of grain and grain boundary deterioration at 1300 C. Statistically significant strength reductions were seen in samples exposed to hydrogen for times greater than 50 hr and temperatures above 1100 C. Critical fracture origins were identified by fractography as either general grain boundary corrision at 1100 C or as corrosion pits at 1300 C. A maximum strength decrease of approximately 33 percent was seen at 1100 and 1300 C after 500 hr exposure to hydrogen. A computer assisted thermodynamic program was also used to predict possible reaction species of SiC and hydrogen.

**20637 (PB—87-126264/XAB) Predictive criteria for low-hysteresis metal hydrides (materials research). Final report on Phase, 1 January-July 1984.** Lynch, F.E. (Hydrogen Consultants, Inc., Denver, CO (USA)). Jul 1984. 51p. NTIS, PC A04/MF A01.

Principles for formulating and processing alloys which exhibit minimal-pressure hysteresis during the absorption and desorption of hydrogen were sought. The study focused on the AB5-type, rare-earth transition metal hydrides, typified by LaNi5. Three types of hysteresis were identified: dynamic, static, and activation hysteresis. Data from the literature and from the study show that static hysteresis can be virtually eliminated. For activation hysteresis, the amount of work needed to fully activate a hydride alloy can be reduced by metallurgical methods and by milling the materials extensively prior to activation. Finally, it was found that true thermodynamic equilibrium can be reached experimentally by cyclic methods.

**20638 (SAND—86-2448C) Hydrogen interactions with oxides in metals: An ion-beam study.** Myers, S.M. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 17p. (CONF-870466—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE87005877.

From International conference on environmental degradation of engineering materials; University Park, PA, USA (13 Apr 1987).

Experiments utilizing ion implantation and nuclear-reaction analysis have quantitatively characterized three hydrogen-binding mechanisms associated with oxide precipitates in Cu, Pd and Al. These basic mechanisms have the potential of influencing hydrogen behavior in numerous alloy systems. In Cu containing $Cu_2O$ particles, and also in Pd containing PdO, reduction of the oxide by hydrogen to form water and/or hydroxide is the dominant process, even near room temperature. It is demonstrated that these strongly exothermic reactions can be conveniently exploited to measure both hydrogen permeability and ambient fugacity, and it is further suggested that such unstable oxides in bulk alloys could serve to retard detrimental hydrogen penetration. In Al containing $Al_2O_3$ precipitates, two oxide-associated trapping mechanisms not involving a phase change were observed; the weaker is believed due to the formulation of $H_2$ molecules at the metal-oxide interface, whereas the stronger is tentatively attributed to chemical bonding at oxide defects.

**20639 Valence-band photoemission in $UO_2$(111) near the 5d resonant photon energy.** Cox, L.E.; Ellis, W.P.; Cowan, R.D.; Allen, J.W.; Oh, S.h.; Lindau, I.; Pate, B.B.; Arko, A.J. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 11, 5761-5765(15 Apr 1987).

Pronounced Fano-like resonant effects are observed in the photoemission spectra of the localized U 5f and OXp ndash: UXf,6d: bonding bands of $UO_2$ when photon energies near the U 5d/sub 3/2,5/2/ thresholds (105 and 97.1 eV, respectively) are employed. The constant-final-state spectra are well described by calculated transition energies and oscillator strengths for the 5d/sup 10/ $5f^2 \rightarrow$/sup h//sup $\nu$/$5d^9 5f^3$ process; also, the decay rates of the intermediate-state multiplets are in qualitative agreement with the observed width of the spectral features. Distinctly different constant-initial-state (CIS) spectra are obtained at the intensity maximum of the U 5f photopeak and at the minimum between the 5f peak and the O 2p bonding band. Calculated decay rates indicate that this results from variations in the branching ratio for decay of intense intermediate-state multiplets into $^2$F/sub 5/2/ and $^2$F/sub 7/2/ final states. Resonant effects in the OXp ndash: UXf,6d: bonding band show the bonding participation of U orbitals; moreover, the higher intensity of the CIS spectrum obtained near the top of the bonding band agrees with band-structure calculations showing most of the U 5f character in this region.

**20640 Structural ceramics based on $Si_3N_4$—$ZrO_2$(+$Y_2O_3$) compositions.** Lange, F.F.; Falk, L.K.L.; Davis, B.I. (Rockwell International Science Center, Structural Ceramics Group, 1049 Camino Dos Rios, Thousand Oaks, California 91360). *Journal of Materials Research;* **2**: No. 1, 66-76(Jan 1987).

An investigation was made of the effect of $Y_2O_3$ in solid solution in $ZrO_2$ on the phases that are formed when $ZrO_2$ is reacted with either $N_2$ or $Si_3N_4$. The results suggest that the Zr—oxynitride phase can be precluded as a reaction product when the $Y_2O_3$ content of the $ZrO_2$ is ≧ 4 mol %. Dense $Si_3N_4/ZrO_2(+Y_2O_3)$ composites were fabricated, which did not degrade during oxidation at temperatures ≦ 1000 °C. Severe degradation was observed for composites containing the Zr—oxynitride phase. The fracture toughness of the $Si_3N_4/ZrO_2(+Y_2O_3)$ composites increased with $ZrO_2$ content.

20641 **Ion implanted precipitate microstructure and mechanical properties of ceramic surfaces.** Cochram, J.K.; Pope, S.G.; Legg, K.O.; Legg, S.H.F. (Georgia Institute of Technology, School of Materials Engineering, Atlanta, GA). *Journal of Materials for Energy Systems;* **8**: No. 2, 121-127(Sep 1986).

Microstructure of precipitates produced by annealing ion implanted surfaces have been investigated in the Al/sub 2/O/sub 3-/ ZrO/sub 2/ system and both microhardness and indentation fracture toughness have been measured for correlation with microstructure. Air annealing of 190 keV high dose implants of Al/sup +/ in yttria-stabilized zirconia and Zr/sup +/ in Al/sub 2/O/sub 3/ have resulted in Al/sub 2/O/sub 3/ and ZrO/sub 2/ precipitates, respectively, as would be expected from phase equilibria. However, annealing schedules drastically alter precipitate microstructure (i.e., crystallite size, morphology, orientation), and changes in microstructure have produced significant variation of surface mechanical properties. Crystallization of the ZrO/sub 2/ films on Al/sub 2/O/ sub 3/ was observable by conventional XRD. The precipitated ZrO/sub 2/ was in the monoclinic structure if the grain size was large or in the tetragonal state if grain size was small. Being able to produce tetragonal ZrO/sub 2/ particles in Al/sub 2/O/sub 3/ surfaces suggests the possibility of transformation toughening and strengthening.

20642 **High temperature failure of ceramics.** Dalgleish, B.J.; Slamovich, E.; Evans, A.G. (Center for Advanced Materials, Lawrence Berkeley Lab.). *Journal of Materials for Energy Systems;* **8**: No. 2, 211-225(Sep 1986). Contract AC03-76SF00098.

Microstructural heterogeneities are observed to have a dual influence on the creep rupture behaviour of a polycrystalline alumina. The duality is related to a transition in rupture mechanism. The heterogeneous regions in the microstructure provide the cracks which cause creep crack propagation controlled failures at small strains. Additionally, shear bands nucleate at the heterogeneities, and thereby contribute to damage controlled failure at large strains. The transition in rupture mechanism is associated with a high incidence of creep blunting of cracks at a threshold stress intensity factor.

20643 **Ultrasonic characterization of machining damage in ceramics.** Clarke, L.R.; Chou, C.H.; Khuri-Yakub, B.T.; Marshall, D.B. (Rockwell Intl. Science Center, Thousand Oaks, CA). pp 1499-1507 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

Two ultrasonic techniques for characterizing machining damage, a 50 MHz broadband pulse-echo technique and a variable-frequency scanning acoustic microscope technique are described. Crack behavior and fracture data for a series of single-crack (simulated machining damage) samples with no residual stress are presented. The surface wave technique provides information on surface roughness, crack size, and crack spacing, but is slow and not easy to use since the sample-transducer geometry is important and a Fourier transform must be computed for each data point. The acoustic microscope technique can be used to quickly identify caracks of specific depths corresponding to the scanning frequency; alignment is not as critical, and no Fourier transform is required, but crack spacing information is less available and multiple scans are now required. Both methods allow quantitative predictions of the fracture strength of the sample to be made, provided that a 20-25% correction is applied to the data.

20644 **Toughening of ceramics by whisker reinforcement.** Becher, P.F.; Ogle, J.C.; Tiegs, T.N.; Warwick, W.H. (Oak Ridge National Lab., Oak Ridge, TN). pp 61-74 of Fracture of mechanics of ceramics. Vol. 7. Bradt, R.C.; Evans, A.G.; Hasselman, D.P.; Lange, F.F. New York, NY; Plenum Press (1986). (CONF-8506128—).

From 4. international symposium on the fracture mechanics of ceramics; Blacksburg, VA, USA (18 Jun 1985).

These studies focus on improvements in the mechanical performance of ceramics by consideration of composite toughening approaches. Analysis of toughening processes indicated that both crack deflection and whisker pull out mechanisms can contribute to the fracture toughness of ceramics which contain strong small diameter whiskers. Results show that these processes can indeed yield high toughness in SiC whisker reinforced ceramics.

20645 **Graphical methods for determining the nonlinear fracture parameters of silica and graphite refractory composites.** Sakai, M.; Bradt, R.C. (Univ. of Washington, Seattle, WA). pp 127-142 of Fracture of mechanics of ceramics. Vol. 7. Bradt, R.C.; Evans, A.G.; Hasselman, D.G.; Lange, F.F. New York, NY; Plenum Press (1986). (CONF-8506128—).

From 4. international symposium on the fracture mechanics of ceramics; Blacksburg, VA, USA (18 Jun 1985).

The energy principle of the nonlinear fracture of ceramic composites is discussed and the nonlinear energy fracture parameters, i.e., the nonlinear energy fracture toughness (G /SUB c/ ), the crack-growth resistance (R /SUB c/ ) and the irreversible energy dissipation (/phi/ /SUB ir/ ) are explained. Four distinct graphical methods are described to evaluate these nonlinear fracture parameters. Nonlinear effects of the microcrack frontal process zone and its wake on these fracture resistance parameters are discussed. The graphical procedures for their evaluation are illustrated for a synthetic polygranular graphite composite and for four different silica refractory composites.

20646 **Evolution of the nickel/zirconia interface.** Shinde, S.L.; Olson, D.A.; De Jonghe, L.C.; Miller, R.A. (Lawrence Berkeley Lab., Materials and Molecular Research, Univ. of California, Berkeley, CA 94720). pp 1027-1031 of Proceedings of the 10th annual conference on composites and advanced ceramic materials. Columbus, OH; American Ceramic Society Inc. (1986). (CONF-860152—). Contract AC03-76SF00098.

From 10. annual conference on composites and advanced ceramic materials; Cocoa Beach, FL, USA (19 Jan 1986).

The changes taking place at the nickel zirconia interface during oxidation in air at 900°C were studied using analytical electron microscopy (AEM). The nickel oxide layer growing at the interface and the stabilizers used in zirconia interact, giving different interface morphologies.

20647 **Evaluation of engineering ceramics by gamma-ray computed tomography.** Taylor, T.; Ellingson, W.A.; Koenigsberg, W.D. (Atomic Energy of Canada, Ltd., Chalk River, Ontario K0J 1J0). pp 772-783 of Proceedings of the 10th annual conference on composites and advanced ceramic materials. Columbus, OH; American Ceramic Society Inc. (1986). (CONF-860152—).

From 10. annual conference on composites and advanced ceramic materials; Cocoa Beach, FL, USA (19 Jan 1986).

Preliminary gamma-ray CT evaluations of a selection of engineering ceramic components have been made. A number of important features were revealed including voids, cracks, and other density anomalies. It has been demonstrated that gamma-ray CT could play a key role in the development of highly reliable engineering ceramics.

20648 **Boron carbide reactive metal cermets: I, thermodynamic considerations in boron carbide titanium cermets.** Halverson, D.C.; Munir, Z.A. (Lawrence Livermore National Lab., Livermore, CA 94550). pp 1001-1010 of Proceedings of the 10th annual conference on composites and advanced ceramic materials. Columbus, OH; American Ceramic Society Inc. (1986). (CONF-860152—).

From 10. annual conference on composites and advanced ceramic materials; Cocoa Beach, FL, USA (19 Jan 1986).

Capillarity and reaction thermodynamic studies were employed to make a preliminary assessment of the feasibility of producing boron carbide-titanium composites. Wetting phenomenon and interfacial reactions are characterized using titanium sessile drop studies on born carbide substrates. Contact-angle measurements are reported and interfacial reaction products are predicted for cermets processed between 1600° and 2200°C. The effects of processing atmosphere (vacuum vs inert) and contaminants (oxygen and carbon) are also considered.

20649 **Degradation mechanisms in thermal-barrier coatings.** Shinde, S.L.; Olson, D.A.; De Jonghe, L.C.; Miller, R.A. (Lawrence Berkeley Lab., Berkeley, CA 94720). pp 1032-1038 of Proceedings of the 10th annual conference on composites and advanced ceramic materials. Columbus, OH; American Ceramic Society Inc. (1986). (CONF-860152—). Contract AC03-76SF00098.

From 10. annual conference on composites and advanced ceramic materials; Cocoa Beach, FL, USA (19 Jan 1986).

The degradation mechanism in a thermal barrier-coating system subjected to prolonged heating in air as well as to thermal cycling was studied. Bond-coat oxidation was found to be the most important reason for degradation. The oxidation produced NiO as well as Al/sub 2/O/sub 3/ in one set of samples, but the variation in initial coating structure made it difficult to resolve systematic differences between isothermally heated and thermally cycled samples. However, the contribution to degradation from changes in substrate composition seemed less in the cycled sample.

20650 **Nuclear magnetic resonance study of vacancy and interstitial motion in scandium hydrides and deuterides.** Jerosch-Herold, M. Ames, IA; Iowa State Univ. (1986). 200p. University Microfilms Order No. 86-27,120.

Thesis (Ph. D.).

Nuclear Magnetic Resonance (NMR) methods were used to study the nonstochiometric dihydrides and dideuterides of high purity scandium. For the first time, measurements were made of the spin relaxation time $T_1$ and $T_2$ of all three nuclear species present ($^{45}Sc$, $^{2}D$, $^{1}H$) in a metal hydride (deuteride) system, permitting a comparison of the main features of both atomic and vacancy motion on the hydrogen sublattice. In the regions of the conventional diffusion induced $^{45}Sc$- and $^{2}D$-$T_1$ minima (<800K), the relaxation rates are dominated by fluctuations of the quadrupolar interaction reflecting vacancy motion. The symmetric $^{1}H$-$T_1$ minimum can be well described by a Lorentzian (Debye) spectral density function. In contrast, the $^{45}Sc$-$T_1$ minimum shows for ln($Sc$-$T_1$) versus reciprocal temperature a substantially smaller slope on the high temperature side at high vacancy concentrations. ($^{45}Sc$-$T_1$)/sub min/ saturates rapidly for vacancy concentrations larger than c/sub v/ > 0.03 and shows a weaker frequency dependence than expected. The jump-attempt frequencies $nu_0$ obtained from the $^{45}Sc$-$T_1$ data agree well with the values obtained from neutron scattering measurements, whereas the $^{1}H$-$T_1$ data yield anomalously low jump frequency prefactors. Departure of the $^{45}Sc$ results from the Lorentzian model are interpreted as indicating the formation of vacancy pairs and the importance of particle-particle interactions.

20651 **Fracture analysis of glass surfaces.** Mecholsky, J.J. (Sandia Natl. Lab., Albuquerque, NM). pp 569-590 of Strength of inorganic glass. Kurkjian, C.R. New York, NY; Plenum Press (1985). (CONF-8303224—).

From NATO advanced research workshop entitled strength of glass; Algarve, Portugal (21 Mar 1983).

New discoveries in fractography which allow one to analyze fracture surfaces more effectively are discussed. These discoveries include changes in the mirror to flaw size ratio with strain rate. The discovery of the cavitation scarp allows one to identify the boundary of the critical flaw. Identification of fracture initiating cracks on surfaces which have been etched or blunted aids in studying the effect of sharp and blunt cracks on fracture. The identification and analysis of indentation cracks has expanded the whole field of fractography in analyzing fractures and associating these analyses with fracture mechanics.

## 3606 Other Materials

*REFER ALSO TO CITATION(S) 20004, 20100, 20107, 20121, 20228, 20229, 20281, 20284, 20531, 20597, 20598, 20599, 20610, 20622, 20631, 20846, 20879, 20880, 20880, 20886, 20886, 20886, 20966, 21760*

20652 **(AD-A—175154/4/XAB) Fiber wetting and coatings for composite fabrication. Technical report.** Katzman, H. (Aerospace Corp., El Segundo, CA (USA). Materials Sciences Lab.). 15 Oct 1986. 35p. (TR—0086A(2935-14)-1). NTIS, PC A03/MF A01.

Graphite fibers resist wetting when immersed in most molten metals. They must be coated with a material that can be wet and that also protects the fibers against chemical degradation during processing. A model of the graphite fiber surface is proposed, and a brief history of coatings that have been investigated for wetting is presented. The titanium-boron chemical vapor deposition process is discussed as well as the graphite-metal interface that results from that process. Finally, Aerospace-developed air-stable coatings and their processing are described. The technique used by Aerospace is a solution-coating process. The fibers are passed through appropriate organometallic solutions followed by either hydrolysis or pyrolysis of the organometallic compounds to form the desired coating on the fiber surfaces. Fibers were coated with selected oxides, nitrides, and carbides, using this technique. Also, a modification of this technique can be used to coat fibers with amorphous carbon. These coatings can be applied to other fibers as well as graphite, and some are easily wet by metals. In addition, the coatings are expected to be useful for controlling the fiber-matrix bond strength in ceramic-matrix composites.

20653 **(AD-A—175471/2/XAB) Low-temperature structures of Xe on graphite in the one- to two-layer regime.** Hong, H.; Birgeneau, R.J.; Sutton, M. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Physics). 1 Mar 1986. 4p. NTIS, PC A02/MF A01.

Published in Physical Review B, Vol. 33, No. 5, 3344-3348(1 Mar 1986).

Low-temperature structures of xenon overlayers on graphite were investigated with coverages ranging from 0.8 to 1.7 square root of (3) monolayers. Below 60 K, the full monolayer has an incommensurate structure that appears to correspond to a rectangular striped phase rather than the square root of (3) commensurate structure inferred from previous electron-diffraction studies. With increasing coverages, there is a first-order transition from the monolayer striped phase to a bilayer hexagonal structure close to that of bulk xenon.

20654 **(AD-A—175497/7/XAB) Electronic transport and microstructure in $MoSi_2$ thin films.** Martin, T.L.; Mahan, J.E. (Colorado State Univ., Fort Collins (USA)). Jun 1986. 11p. NTIS, PC A02/MF A01.

Published in J. of Material Research, Vol. 1, No. 3, 493-502(May/Jun 1986).

Molybdenum disilicide thin films having the tetragonal crystal structure were prepared by furnace reaction of ion-beam-sputtered molybdenum layers with silicon substrates. The room-temperature intrinsic resistivity is approx. microhms/cm. The Hall effect indicates predominantly hole conduction. Geometrical magnetoresistance measurements provide a carrier mobility estimate of 90 sq. cm/V.s at room temperature. The Hall mobility is much less than this; the large difference between the two mobility values suggests multiband conduction. An isotropic, degenerate, two-band model may be fitted to the data with a comparatively low majority-carrier concentration (holes) of approx. $1.5 \times 10^{21}/cm^3$. Regarding the effects of microstructure on transport, the residual resistivity for films formed on 1-0-0 silicon wafers is much greater than for those formed on an (LPCVD) polysilicon layer: 92 vs 29 microhms/cm, respectively. A correlation with average grain size for the two

sample types suggests that grain-boundary scattering is the principal cause of the residual resistivity.

20655 **(AD-A—175554/5/XAB) Study of the nature of fracture failure in composite materials. Final report, 1 May 1985-31 August 1986.** Rao, R.N. (Prairie View A and M Univ., TX (USA). Coll. of Engineering). 1 Dec 1986. 8p. NTIS, PC A02/MF A01.

The boron, aluminum composite material samples were cut to shape and subjected to push-pull type of loading under Instron Servo Hydrolic test system to failure. The failure surfaces were examined under electron microscope. The data collected under about ten experiments were used for an M.S.E. thesis of one graduate student.

20656 **(DOE/ER/45102—T1) [Novel polymeric LIT and divalent cation fast ion conducting materials]: Annual technical report.** Angell, C.A. (Purdue Univ., Lafayette, IN (USA). Dept. of Chemistry). 1986. Contract FG02-84ER45102. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006294.

Solid state energy devices require a component which conducts electricity by ionic migration. The conductivity of this element of the system must be very high. Four types of materials show the promise to provide the necessary conductivity characteristics, while offering other desirable features such as the ability to distort in shape under mechanical stresses: (1) crystalline; (2) plastic crystal; (3) inorganic glassy; and (4) polymer salt solutions. This document reports on the following materials: lead halide-containing fast ion conducting glasses ($LiF\text{-}PbF_2\text{-}Al(PO_3)_3$), mixed ionic electronic conduction ($Na_2O\text{-}V_2O_5\text{-}TeO_2$), $\alpha$ relaxation in ionic glasses, glass transition in $P_2O_5$, and conductivity transition between all-halide and all-oxide glasses. 8 figs. (DLC)

20657 **(DP—1733) WIPP [Waste Isolation Pilot Plant]/ SRL in situ tests: Part 2, Pictorial history of MIIT [Materials Interface Interactions Tests] and final MIIT matrices, assemblies, and sample listings.** Wicks, G.G.; Weinle, M.E.; Molecke, M.A. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Jan 1987. Contract AC09-76SR00001. 244p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE87006358.

In situ testing of Savannah River Plant [SRP] waste glass is an important component in ensuring technical and public confidence in the safety and effective performance of the wasteforms. Savannah River Laboratory [SRL] is currently involved in joint programs involving field testing of SRP waste in Sweden, Belgium, and the United Kingdom. Most recently, this in situ effort has been expanded to include the first field tests to be conducted in the United States, involving burial of a variety of simulated nuclear waste systems. This new effort, called the Materials Interface Interactions Tests or MIIT, is a program jointly conducted by Sandia National Laboratory/Waste Isolation Pilot Plant [WIPP] and SRL. Over 1800 samples, supplied by the United States, France, West Germany, Belgium, Canada, Japan, and the United Kingdom, were buried approximately 650m below the earth's surface in the salt geology at WIPP, near Carlsbad, New Mexico. The MIIT program is one of the largest cooperative efforts ever undertaken in the waste management field; the data produced from these tests are designed to benefit a wide cross-section of the waste management community. An earlier document provided an overview of the WIPP MIIT program and described its place in the waste glass assessment program at Savannah River. This document represents the second in this series and its objectives include: (1) providing a pictorial history of assembly and installation of wasteforms, metals, and geologic samples in WIPP; (2) providing 'finalized and completed' sample matrices for the entire 7-part MIIT program; (3) documenting final sample assemblies by the use of schematic drawings, including each sample, its orientation, and its environment; and (4) providing a complete listing of all samples and the means for managing analyses and resulting data.

20658 (INIS-mf—10565, pp 42-45) **Effect of silver addition on microhardness of lead-tin telluride.** Aleksandrov, O.V.; Zelikman, I.N.; Kiseleva, K.V. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780085.

Kratkie Soobshcheniya po Fizike. No. 3.
In Experimental and theoretical physics. Collection.

Effect of silver addition on Pbsub(0.8)Snsub(0.2)Te microhardness is investigated within the (0.2-3) x 10/sup 17/ cmsup(-1) concentration range. A sharp drop of microhardness is found at Ag content above 10/sup 17/ cmsup(-3), that is explained by increased concentration of thermodynamically equilibrium vacancies in Pbsub(0.8)Snsub(0.2)Te.

20659 **(JAERI—1299) Diffusion and solubility of oxygen in $\gamma$-ray irradiated polymer insulation materials.** (Japan Atomic Energy Research Inst., Tokyo). Mar 1986. 68p. NTIS (US Sales Only), PC A04/MF A01. File Number DE87700999.

The effects of /sup 60/Co $\gamma$-rays irradiation on diffusion and solubility of oxygen in polymer materials for electric cable insulation materials were investigated. The polymers were polyethylene, ethylene-propylene rubber, chlorinated polyethylene, chlorosulphonated polyethylene, and chloroprene rubber. They were pure grade and several types of formulation grade. The sheets of these polymers were irradiated up to 5 - 200 Mrad under vacuum or in oxygen under pressure of 3 - 15 atm at room temperature or at 70 deg C. By a method of gas desorption, the diffusion coefficient (D) and solubility coefficient (S) of oxygen or argon in polymer materials were determined at various temperatures of 10 - 80 deg C. The D and S decreased with increase of dose, and the decrease by irradiation with oxidation was more remarkable than that by irradiation without oxidation. However, the decreases of D and S by irradiation were reduced by the formulation of polymers. The additives in formulated polymers would reduce the reactions of crosslinking or oxidation by $\gamma$-ray irradiation. The activation energy of D was scarcely changed by irradiations with and without oxidation.

20660 **(JAERI-M—85-150) On moisture migration in a heated concrete.** (Japan Atomic Energy Research Inst., Tokyo). Oct 1985. 32p. (In Japanese). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701001.

Transient moisture migration in a slab of porous concrete being heated at one surface was analyzed with consideration of evaporation and condensation effects. Analysis was made in the existence of non-condensable fluid (air). Since partial differential equations which describe the total system are very complicated, the existence of similar solution is assumed under the condition of low dry-wet interface temperature. Then, partial differential equations were transformed into ordinary differential equations. Solutions were obtained for two boundary conditions of a permeable outer surface and a impermeable outer surface.

20661 **(JAERI-M—85-160) High-temperature anisotropy study of nuclear grade graphite by neutron scattering technique.** (Japan Atomic Energy Research Inst., Tokyo). Oct 1985. 13p. (In Japanese). NTIS (US Sales Only), PC A02/ MF A01. File Number DE87701002.

A neutron scattering technique was applied to determine the orientation function, I(phi), of some nuclear graphites and the advantage of this method was described. The anisotropy change was also studied on thermal expansion of bulk graphite in terms of I(phi) and expansion coefficients of unit lattice. No change was detected for I(phi) from room temperature to 900 deg C, but the anisotropy factor of bulk graphite showed a tendency to decrease with temperature corresponding to the change in expansion coefficients of unit lattice.

20662 **(JAERI-M—85-220) Studies on radiation resistance of fiber reinforced plastic composites featured by easiness of manufacturing. 1. Degradation behavior under electron irradiation at room temperature.** Udagawa, Akira; Hagiwara, Miyuki; Kawanishi, Shunichi. (Japan Atomic Energy Research Inst., Tokyo). Jan 1986. 31p. (In Japanese). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701014.

Degradation behavior of fiber reinforced plastic (FRP) composite materials manufactured by conventional lamination technology was studied by measuring various mechanical properties after irradiation and observing fracture surfaces by scanning electron mi-

croscopy. When bisphenol-A type epoxy was used as matrix material, the laminated composites degraded rapidly. This fact was ascribed to poor radiation resistance of the matrix resin. The radiation resistance varied depending on types of hardeners. Diaminodiphenylmethane (DDM) gave radiation resistance higher than diaminodiphenylsulfone (DDS). The dose that produced an incipient decrease in mechanical properties (threshold dose) was larger in case of carbon fiber reinforcement than glass fiber reinforcement. For example, the threshold dose was about 10 MGy in case of glass fiber reinforcement with epoxy matrix hardened by DDS, and about 30 MGy when hardened by DDM. While, it increased to about 60 MGy with the latter matrix when carbon fiber is used. From the results of scanning electron microscopic observation of fractured surfaces, the superior radiation resistance in case of carbon fiber reinforcement was found due to its stable bonding interface between fiber and matrix. When BT (bismaleimide-triazine) resin was used as matrix for glass fiber reinforcement, little influence of irradiation was observed in various mechanical properties at least up to 60 MGy, and three point flexural strength showed no change even up to 100 MGy. This stability was ascribed to the stability of both the matrix resin and the bonding interface. Interlaminar shear strength reflects radiation effects on FRP with highest sensitivity among various mechanical properties tested in this work.

20663 **(SAND—86-1730) Fabrication of multiple-layer large ice block.** Hudson, S.L. (Sandia National Labs., Albuquerque, NM (USA)). Feb 1987. Contract AC04-76DP00789. 25p. NTIS, PC A02/MF A01. File Number DE87006789.

An automated process to fabricate large ice blocks was developed. One-dimensional heat transfer considerations, the system operating equipment, and the large ice block characteristics are discussed. Ice blocks up to 9 ft thick and weighing over 30,000 lb have been fabricated with this technique in less than 10 days.

20664 **(UCID—20979) Influence of notch depth on tearing morphology and tearing energy in carbon-black-loaded SBR [styrene butadiene rubber].** Goldberg, A.; LeMay, J.D.; Sanchez, R.J.; Stone, J.C.; Patt, J. (Lawrence Livermore National Lab., CA (USA); Army Tank-Automotive Command, Warren, MI (USA)). 30 Jan 1987. Contract W-7405-ENG-48. 77p. NTIS MF A01; 2; GPO Dep. File Number DE87005932.

Tearing energies (T) have been evaluated for carbon-black-reinforced SBR tested in uniaxial tension. The influence of notch depth on T and fracture morphology have also been determined. The influence of notch depth on the stress-strain behavior and on the failure stress and failure strain is also illustrated. The ratio of recovered-to-input energy as a function of both stress and strain was determined for notched and notch-free samples.

20665 **(UCRL—95868) Thermal properties of Permian Basin evaporites to 493 K and 30 MPa confining pressure.** Durham, W.B.; Heard, H.C.; Boro, C.O.; Keller, K.T.; Ralph, W.E.; Trimmer, D.A. (Lawrence Livermore National Lab., CA (USA)). 26 Jan 1987. Contract W-7405-ENG-48. 78p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87006689.

Laboratory measurements have been made of the thermal conductivity and diffusivity of four rock salts, two anhydrites, and two dolomites bordering the Cycle 4 and Cycle 5 bedded salt formations in the Permian Basin in Deaf Smith County, Texas. Measurement conditions ranged from 303 to 473 K in temperature, and 0.1 to 31.0 MPa in hydrostatic confining pressure. Within the +- 5% measurement resolution neither conductivity nor diffusivity showed a dependence upon pressure in any of the rocks. Conductivity and diffusivity in all rocks had a negative temperature dependence. For the two Cycle 4 salt samples, conductivity over the temperature range explored fell from 5.5 to 3.75 W/m.K, and diffusivity fell from about 2.7 to 1.7 x $10^{-6}$ $m^2/s$. One of the Cycle 5 salts was a single crystal which had anomalous results, but the other had a low conductivity, about 3.4 W/m.K, with very weak temperature dependence, and a high diffusivity, 3.8 to 2.5 x $10^{-6}$ $m^2/s$ over the temperature range. In the nonsalts, conductivity and diffusivity decreased 10 to 20% over the temperature range explored, which was $308 < T < 373$ K. Typical values at 308 K for conductivity were 5.4 W/m.K for both anhydrites and 3.4 and 2.6 W/m.K for the two different dolomite samples. Approximate values at 308 K for diffusivity were 2.3 x $10^{-6}$ $m^2/s$ for the anhydrites and 1.4 x $10^{-6}$ $m^2/s$ for both the dolomites. The coefficient of thermal linear expansion was measured for the Cycle 5 salt and nonsalts over $308 < T < 493$ and $0.1 < P < 30.0$ MPa. Typically, the coefficient varied from about 12 x $10^{-6}$ $K^{-1}$ at P = 3.0 MPa to 4 x $10^{-6}$ $K^{-1}$ at P = 30 MPa for both nonsalt rocks. In anhydrite, it decreased with increasing temperature at a rate of roughly 5 x $10^{-8}$ $K^{-2}$ at all pressures. In dolomite, the coefficient increased at roughly the same rate. Expansion of the salt ranged from 33 to 38 x $10^{-6}$ $K^{-1}$ and was independent of pressure and temperature.

20666 **GaSb films grown by vacuum chemical epitaxy using triethyl antimony and triethyl gallium sources.** Fraas, L.M.; McLeod, P.S.; Partain, L.D.; Cape, J.A. (Chevron Research Co., Richmond, California 94802). *Journal of Applied Physics;* **61**: No. 8, 2861-2865(15 Apr 1987).

GaSb films have been grown using triethyl-Ga and triethyl-Sb sources. In a hot-wall reaction chamber located within a high-vacuum chamber, multiple group-III alkyl molecular beams are directed into the reaction chamber onto wafers. The group-V molecules are injected from the perimeter of the reaction chamber and undergo molecular flow across the deposition zone. The utilization efficiency of the group-V source material is enchanced by the use of a thermal cracker located at the point of group-V gas injection and by the use of the hot-wall chamber. Both unintentionally doped p-type and Te doped n-type GaSb films are grown and characterized. GaSb p-n junction photodiodes are also reported with internal quantum yields as high as 85%. Unintentionally doped films were shown to have background carrier concentrations of 4 x $10^{16}$ $cm^3$ by capacitance versus voltage measurement.

20667 **Analytical theory of electron-beam-induced damage in organic materials.** Garcia-Molina, R.; Gras-Marti, A. (Laboratori de Capes Fines i Colxlisions Ato-grave-accentmiques, Departament de Fisica Aplicada, Facultat de Ciencies, Universitat d'Alacant, Apartat 99, E-03080 Alacant, Spain). *Journal of Applied Physics;* **61**: No. 8, 3105-3107(15 Apr 1987).

We calculate analytically the damage produced in a slab of organic material irradiated by an electron beam as a function of electron energy. The treatment is based on a Boltzmann-type transport equation. We assume that the damage is directly related to the number of carbon K-shell ionizations produced by the electron bombardment. An acceptable agreement between our calculations and experimental data is found.

20668 **Diatomic melting curves to very high pressure.** Young, D.A.; Zha, C.; Boehler, R.; Yen, J.; Nicol, M.; Zinn, A.S.; Schiferl, D.; Kinkead, S.; Hanson, R.C.; Pinnick, D.A.; and others. (Lawrence Livermore National Laboratory, University of California, Livermore, California 94550). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 10, 5353-5356(1 Apr 1987).

Using new high-temperature diamond-anvil-cell designs, together with a variety of optical techniques, we have measured the melting curves of $N_2$ to 18.0 GPa, $O_2$ to 16.3 GPa, and $F_2$ 2.5 GPa. One triple point is found on the $N_2$ curve and two on the $O_2$ curve. A simple "effective rotation" model of librational motions in the solid is used to obtain good theoretical fits to the experimental curves.

20669 **Dc electrical resistivity and upper critical magnetic field of superconducting ternary silicides and germanides with the $Sc_5Co_4Si$/sub 10/-type structure.** Hausermann-Berg, L.S.; Shelton, R.N. (Ames LaboratoryU.S. Department of Energy and Department of Physics, Iowa State University, Ames, Iowa 50011). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 10, 4673-4676(1 Apr 1987). Contract W-7405-ENG-82.

Results of dc electrical resistivity experiments are presented for eleven ternary superconducting compounds of the form $R_5T_4X$/sub 10/ (R = Sc, Y, and Lu; T = Co, Rh, Ir, and Os; X = Si or Ge). Upper critical magnetic field results are presented for

$Sc_5Co_4Si$/sub 10/, $Sc_5Rh_4Si$/sub 10/, $Sc_5Ir_4Si$/sub 10/, $Lu_5Rh_4Si$/sub 10/, $Lu_5Ir_4Si$/sub 10/ and $Y_5Os_4Ge$/sub 10/. Electrical-resistivity experiments show strong negative curvature in the data for $Y_5Ir_4Si$/sub 10/, $Lu_5Ir_4Ge$/sub 10/, and $Y_5Os_4Ge$/sub 10/ plus a sharp anomaly at about 140 and 80 K for $Lu_5Rh_4Si$/sub 10/ and $Lu_5Ir_4Si$/sub 10/, respectively. Analysis of the upper critical magnetic field yields relatively large values of (-dH/sub c/$_2$/dT)/sub =/—10 kOe/K and H/sub c/$_2$(0)—60 kOe for $Y_5Os_4Ge$/sub 10/ as well as indicating that there is little or no Pauli limiting in these six samples.

20670 **Optical properties of strained-layer superlattices with growth axis along [111].** Smith, D.L.; Mailhiot, C. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review Letters;* **58**: No. 12, 1264-1267(23 Mar 1987).

We show that large piezoelectrically induced electric fields strongly modify the optical properties of [111] growth axis strained-layer superlattices with growth axis along [111]. These internal fields reduce the superlattice band gap, change optical matrix elements, and cause a spatial separation of photoexcited electrons and holes so as to screen the fields. Very large (chi$^3$—10/sup -1/ esu) optical nonlinearities occur because of the free-carrier screening of the strain-generated internal electric fields.

20671 **Transverse fluctuations in an Ising spin-glass: Fe/sub 0.4/Mg/sub 0.6/$Cl_2$.** Wong, P.; Yoshizawa, H.; Shapiro, S.M.; Mydosh, J.A.; van den Berg, J.; Palstra, T.T.M. (Schlumberger-Doll Research, Ridgefield, Connecticut 06877). *Physical Review Letters;* **58**: No. 12, 1276-1279(23 Mar 1987).

ac-susceptibility and neutron-diffraction experiments show that Fe/sub 0.4/Mg/sub 0.6/$Cl_2$ is a three-dimensional Ising spin-glass with a transition temperature T/sub sg/ = 3.4 K. Inelastic-scattering experiments show a sharp spin-wave peak at the zone center for all temperature Tapprox. <2T/sub sg/. This is the first direct observation of long-wavelength excitation in a spin-glass system. We suggest that it is due to the precession of spin clusters around the easy axis.

20672 **Theoretical study of a $Cu^+$ ion impurity in a NaF host.** Winter, N.W.; Pitzer, R.M.; Temple, D.K. (Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Chemical Physics;* **86**: No. 6, 3549-3556(15 Mar 1987). Contract W-7405-ENG-48.

The $Cu^+$ ion impurity in a NaF host has been modeled using a finite cluster of ions to represent the crystal lattice. Several approximations to the lattice potential in the region of the cluster were compared to the exact Madelung potential. The error in the calculated nearest-neighbor distance for the pure host was found to be proportional to the error in the lattice potential. Hartree—Fock calculations were carried out for the ground $^1A_1$/sub g/ and excited /sup 1,3/E/sub g/ and /sup 1,3/$T_2$/sub g/ states of the NaF:$Cu^+$ system. The resulting energy level structure was compared to the experimental spectra. The symmetric-stretch potential energy curve, vibrational frequencies, and Franck—Condon factors were calculated for the $^1A_1$/sub g/ and /sup 1,3/$T_2$/sub g/ states. Using a single configuration coordinate model and a semiempirical spin—orbit coupling scheme, the relative intensities and bandwidths were calculated for absorption to the /sup 1,3/$T_2$/sub g/ states and compared to experiment.

20673 **Light-scattering cross sections of Ca/sup 2+/ and the calcium—cation-vacancy complex in KBr.** Fredericks, W.J.; Collins, P.R.; Edwards, D.F. (Chemistry Department, Oregon State University, Corvallis, Oregon 97331). *Physical Review [Section] B: Condensed Matter;* **35**: No. 6, 2999-3002(15 Feb 1987).

Measurements of a scattering ratio eta/sub T/ as a function of total calcium concentration were used to estimate the scattering cross section $\sigma$ of Ca/sup 2+/ and the calcium—cation-vacancy complex as impurities in KBr. As theory predicts, no difference in $\sigma$ for these species was detected. The experimental $\sigma$ for these species was 5.9 x 10/sup -26/ cm$^2$, about an order of magnitude larger than the theoretical value.

20674 **Process for producing chalcogenide semiconductors.** Noufi, R.; Chen, Y.W. (to Dept. of Energy, Washington, DC). US Patent 4,642,140. 10 Feb 1987. Filed date 30 Apr 1985. vp.

A process is described for producing a chalogenide semiconductor material for use in photovoltaic semiconductor devices, the process comprising: a. forming a solution containing ions from at least one chalcogen and providing the solution with a pH in a range of 1-2 so as to provide the semiconductor material with suitable performance characteristics when used as the photovoltaic semiconductor device; b. forming a metal base layer containing a sufficient number of metal elements to form at least a ternary chalcogenide semiconductor material upon being chalcogenized with the solution; and c. contacting the metal base layer with the solution at about ambient temperature so as to chalcogenize the metal base layer and form at least ternary chalcogenide semiconductor material.

20675 **Influence of microstructure on the photoconductivity of glow discharge deposited amorphous SiC:H and amorphous SiGe:H alloys.** Mahan, A.H.; Raboisson, P.; Tsu, R. (Solar Energy Research Institute, Golden, Colorado 80401). *Applied Physics Letters;* **50**: No. 6, 335-337(9 Feb 1987). Contract AC02-83CH10093.

We introduce a parameter obtained from infrared measurements as a means of quantifying the amount of amorphous silicon microstructure and its degree of passivation by hydrogen. Using this parameter, the photoconductivities of amorphous silicon (a-Si:H), amorphous silicon carbon (a-SiC:H), and amorphous silicon germanium (a-SiGe:H) fall on the same curve. We discuss the relevance of these results with regard to material quality.

20676 **Coordination determination of In on Si(100) from synchrotron photoemission studies.** Rich, D.H.; Samsavar, A.; Miller, T.; Lin, H.F.; Chiang, T.H.; Sundgren, J.H.; Greene, J.E. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Physical Review Letters;* **58**: No. 6, 579-582(9 Feb 1987). Contract AC02-76ER01198.

High-resolution core-level photoemission spectroscopy was used to study the initial growth and interaction of In on Si(100). The In: Si bonding coordination number, determined by quantification of the number of Si surface atoms selectively modified in the presence of an In adatom, is 3 for very low In coverages, and decreases to 2 for (1/2) -monolayer coverage. The results are consistent with a structural model deduced from electron diffraction, Auger, and scanning electron microscopy studies.

20677 **Method of making a piezoelectric shear wave resonator.** Wang, J.S.; Lakin, K.M.; Landin, A.R. (to Dept. of Energy, Washington, DC). US Patent 4,640,756. 3 Feb 1987. Filed date 20 May 1985. vp.

A method is described of depositing a film of piezoelectric material on a substrate, the film having a uniform, controlled, inclined C-axis orientation comprising: providing a dc planar reactive sputtering system having a chamber containing a cathode for holding a target, an anode spaced from and parallel to the cathode for holding the substrate and a reactive gas, establishing an electrical field between the cathode and the anode to sputter the target such that the target material ionizes to form an ion flux which reacts with the reactive gas forming the piezoelectric material which deposits on the substrate, providing a positively biased control electrode in the chamber near the substrate and establishing a second, dc electrical field between the control electrode and the anode to collect the electron current and control the ion flux. The electrode position and the strength of the dc field are sufficient to alter the direction of the ion flux as it strikes the substrate to control the orientation of the C-axis away from the direction of the control electrode. The distance of the electrode above the plane of the substrate and the strength of the second electrical field control the degree of inclination of the C-axis, thereby forming a film of piezoelectric material having a uniform, controlled, inclined C-axis.

20678 **Structural properties of GaAs on (001) oriented Si and Ge substrates.** Neumann, D.A.; Zabel, H.; Fischer, R.; Morkoc, H. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Journal of Applied Physics;* **61**: No. 3, 1023-1029(1 Feb 1987). Contract AC02-76ER01198.

A detailed x-ray scattering study of GaAs grown by molecular beam epitaxy on (001) oriented Si and Ge substrates is reported. It is shown that the broadening of the GaAs Bragg peaks can be understood in terms of residual strains for samples 2 μm thick. For a sample 0.2 μm thick, domain size broadening effects corresponding to the total thickness of the GaAs film must also be included in order to explain the peak widths. In none of the samples was any evidence of antiphase domain broadening observed and we are thus able to place a minimum of 4000 A on the size of any possible antiphase domains. We also find that the GaAs lattice is incommensurate with the Si substrate and that the GaAs is tetragonally distorted at room temperature. This distortion is explained by the difference in the thermal expansion of GaAs and Si.

20679 **Standing wave enhanced scattering in multilayer structures.** Kortright, J.B.; Fischer-Colbrie, A. (Center for X-ray Optics, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Journal of Applied Physics;* **61**: No. 3, 1130-1133(1 Feb 1987). Contract AC03-76SF00098.

X-ray standing waves inside a tungsten-carbon periodic multilayer structure are shown to act as localized probes in the coherent scattering from amorphous interatomic correlations making up the layers of the structure. The distorted wave approximation describes the standing wave formation, and kinematical theory describes the scattering of this standing wave by the amorphous atomic correlations. Possible use of this technique for the study of atomic arrangements and interfaces in multilayer structures is discussed.

20680 **Calculated high-pressure properties of solid acetylene and possible polymerization paths.** LeSar, R. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Chemical Physics;* **86**: No. 3, 1485-1490(1 Feb 1987).

Results of theoretical calculations at 0 K on the two known structures of solid acetylene using the modified Gordon—Kim plus damped dispersion model are reported. The lattice energy of the low temperature Cmca structure is compared to that of the high temperature Pa3 structure at zero pressure and found to be slightly less stable, though a very small pressure (about 0.25 kbar) stabilizes the Cmca structure relative to the Pa3 structure. Agreement between the experimental structure and energy for the Cmca structure and our present results is good. Structural properties of the Cmca structure were calculated to 100 kbar as well as the pressure dependence of the A/sub g/ libron mode. A possible high-pressure path for the polymerization of solid Cmca acetylene that would lead to a well-ordered polymer was proposed, but calculations of C—C distances suggest that a more cross-linked product would be favored.

20681 **Modification of dopant profiles due to surface and interface interactions: Applications to semiconductor materials.** Jagannadham, K.; Narayan, J. (Materials Science and Engineering Department, North Carolina State University, Raleigh, North Carolina 27695-7916). *Journal of Applied Physics;* **61**: No. 3, 985-992(1 Feb 1987).

The kinetics of segregation of dopant solute atoms in the presence of free surfaces and interfaces are analyzed by solving the diffusion equation with a drift term. The drift term includes the configurational interaction energy associated with an oversize or an undersize atom near a coherent interface when the continuity conditions are satisfied. Both an analytical solution and a numerical procedure are provided to solve the problem by eigenfunction expansion method. A new procedure for evaluating the eigenvalues to include higher-order terms is given. It is further established that an attractive force due to either a soft second phase or a free surface gives rise to a minimum in the concentration profile near the interface while a hard second phase results in a monotonically increasing concentration. The position of the minimum in the concentration profile in the presence of a soft second phase or the slope of the concentration profile in the presence of a hard second phase provides a measure of the strength of the defect and the interaction-energy term which can be compared with experimental observations. In particular, we have considered changes in the dopant profiles in silicon under the influence of the free surface, in silicon with silicon dioxide, gallium arsenide, germanium, magnesium oxide and in germanium with silicon, all deposited as a second phase, respectively.

20682 **Correlation between solid-state reaction and electrical properties of the Rh/GaAs Schottky contact.** Yu, K.M.; Cheung, S.K.; Sands, T.; Jaklevic, J.M.; Haller, E.E. (Center for Advanced Materials, Lawrence Berkeley Laboratory and University of California, Berkeley, California 94720). *Journal of Applied Physics;* **61**: No. 3, 1099-1102(1 Feb 1987). Contract AC03-76SF00098.

The solid-state reactions between (100) GaAs substrates and Rh films —150 A and —600 A thick, annealed at temperatures between 300 and 800 °C, are investigated with conventional and heavy ion Rutherford backscattering spectrometry, and x-ray diffraction. Initiation of interface reactions between the Rh films and the GaAs substrate is observed at —300 °C. Laterally segregated RhGa, RhAs, and $RhAs_2$ phases are detected for the 150-A Rh/GaAs contact annealed in the temperature range of 300—700 °C. For thick Rh film (—600 A) on GaAs, vertical phase separation between the RhGa and the Rh-As phases is observed after annealing. After annealing at 700 °C for 20 min, the reaction between the 600-A Rh film and GaAs is complete and a layer sequence of RhGa/$RhAs_2$/GaAs results. Electrical properties of Rh/n-GaAs diodes are measured using the current voltage dependence. A correlation between the electrical behavior and the metallurgical reaction is observed.

20683 **Order-disorder transformation in ternary tetrahedral semiconductors.** Zunger, A. (Solar Energy Research Institute, Golden, Colorado 80401). *Applied Physics Letters;* **50**: No. 3, 164-166(19 Jan 1987).

The recently discovered order-disorder transformations in pseudobinary semiconductor alloys A/sub x/B/sub 1-//sub x/C are shown to belong to a broader class of such transformations in A/sub n/B/sub 4-//sub n/$C_4$ semiconducting compounds (e.g., chalcopyrites, for n = 2). Strain energy, set up by the atomic size mismatch between the A—C and B—C bonds, is shown to control the nature of the state of order in chalcopyrites and pseudobinary alloys alike. These considerations lead to a classification of all bulk tetrahedral semiconductors into four classes of order-disorder characteristics.

20684 **CdS induced homojunction formation in crystalline p-$CuInSe_2$.** Matson, R.J.; Noufi, R.; Bachmann, K.J.; Cahen, D. (Solar Energy Research Institute, Golden, Colorado 80401). *Applied Physics Letters;* **50**: No. 3, 158-160(19 Jan 1987). Contract AC02-83CH10093.

The deposition of CdS onto single-crystal p-$CuInSe_2$ (at a substrate temperature of 200 °C) results in a $CuInSe_2$ homojunction rather than the expected heterojunction. Junction depths, varying from 1 to 9 μm, correlated well with the free-carrier concentration of the sample crystals. The junction depths were measured by electron-beam-induced current line scans of cleaved junctions and were corroborated by quantum efficiency measurements. All the materials deposited to date (CdS, Cd, Au, and Mo) have resulted in type conversion of the $CuInSe_2$. The experimental evidence for this type conversion is presented and possible defect chemical origins identified.

20685 **Are leached porous glasses fractal?.** Schaefer, D.W.; Bunker, B.C.; Wilcoxon, J.P. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Physical Review Letters;* **58**: No. 3, 284-284(19 Jan 1987). Contract AC04-76DP00789.

A comment on the letter by U. Even et al., Phys. Rev. Lett. 52, 2164 (1984).

20686 **Electronic structure of [001]- and [111]-growth-axis semiconductor superlattices.** Mailhiot, C.; Smith, D.L. (Xerox Corporation, Webster Research Center (0114-41D), 800 Phillips Road, Webster, New York 14580). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 3, 1242-1259(15 Jan 1987).

A kxp theory is used to investigate the electronic structure of semiconductor superlattices grown along the [001] and [111] axes. The present work considers the case of Ga/sub 1-//sub x/In/sub x/As-Al/sub 1-//sub y/In/sub y/As superlattices. We specifically treat three alloy composition pairs: a lattice-matched case (x = 0.53, y = 0.52), a case where the Ga-containing layers are in biaxial tension with a 0.8% lattice mismatch (x = 0.53, y = 0.64), and a case where the Ga-containing layers are in biaxial compression with a 1.5% lattice mismatch (x = 0.53, y = 0.30). We analyze the effects of the growth axis on the electronic structure of the superlattice from a consideration of the subband dispersion both parallel and perpendicular to the growth direction. Apart from point-group symmetry considerations, a major factor which differentiates the electronic structure of [001]- and [111]-growth-axis superlattices is the presence of large (exceeding 100 kV/cm) internal strain-induced electric fields in strained-layer superlattices grown along the [111] axis. These internal electric fields are directed along the [111] growth axis and are generated by the internal strain because the constituent semiconductors are piezoelectric. In [001]-growth-axis strained-layer superlattices, the orientation of the lattice-mismatch-induced strains is such that these fields are not present. We demonstrate that the strain-induced electric fields result in sizeable Stark shifts on the superlattice electron and hole subbands and lead to a substantial reduction of the superlattice band gap.

20687 **Conduction-band-edge charge densities in elemental and compound semiconductors.** Richardson, S.L.; Cohen, M.L. (Department of Physics, University of California Berkeley, California 94720 and Center for Advanced Materials, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 3, 1388-1392(15 Jan 1987).

The empirical pseudopotential method is used to compute electronic charge densities at the Γ, L, and X k points of the conduction-band edge in selected group-IV elemental (Si, Ge, α-Sn) and III-V compound (GaP, GaAs, GaSb, InP, InAs, InSb) semiconductors. We find that these charge distributions are essentially independent of the system under study and are strongly dependent upon the symmetry of the wave function of a particular state. As a direct consequence of this analysis, we find that the $\Gamma_1$/sup c/ conduction-band state for the heteropolar semiconductors contains an abundance of charge density associated with the anion as opposed to the cation in support of a previous observation by Baldereschi and Maschke, and that the symmetry of the wave function of the conduction-band edge at X/sup c/ for GaSb is actually $X_3$/sup c/, and not $X_1$/sup c/ as has been previously assigned in the literature. We therefore predict an increase in both the direct and indirect band gaps of the Nowotny-Juza alloy α-LiZnSb upon applying the interstitial insertion rule of Wood, Zunger, and de Groot to GaSb.

20688 **Anisotropy of /sup 39/K binding in $C_8K$ studied by nuclear resonance photon scattering.** Moreh, R.; Sellyey, W.C.; Sutton, D.C.; Zabel, H. (Nuclear Physics Laboratory, Department of Physics, University of Illinois at Urbana-Champaign, Champaign, Illinois 61820; Nuclear Research Centre, Negev, P.O. Box 9001, 84190 Beer-Sheva, Israel; Department of Physics, Ben-Gurion University of the Negev, P.O. Box 653, 84120). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 2, 821-827(15 Jan 1987). Contract AC02-76ER01198.

A new technique employing nuclear resonance photon scattering of bremsstrahlung has been used for studying the anisotropic binding of K atoms in the first-stage intercalated compound $C_8K$. The bremsstrahlung was obtained using an electron beam with E/sub e/ = 8.5 MeV. The scattered intensities from the 5.262- and 6.334-MeV levels in /sup 39/K and from the 4.439-MeV level in /sup 12/C were found to be dependent on the c-axis orientation of $C_8K$ with respect to the photon beam in a nuclear self-absorption measurement. This behavior is interpreted in terms of the anisotropy in the Doppler broadenings of the /sup 39/K and /sup 12/C nuclear levels caused by the zero-point energies of the $C_8K$ vibrational modes along and perpendicular to the graphite basal planes. The measured anisotropy was found to be somewhat higher than that calculated from the known vibrational spectra in $C_8K$.

20689 **Effect of pressure on competing electronic correlations in the heavy-electron system $URu_2Si_2$.** McElfresh, M.W.; Thompson, J.D.; Willis, J.O.; Maple, M.B.; Kohara, T.; Torikachvili, M.S. (Materials Science and Technology Division, Los Alamos National Laboratory, University of California, P.O. Box 1663, Los Alamos, New Mexico 87545). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 1, 43-47(1 Jan 1987).

The heavy-electron compound $URu_2Si_2$ exhibits two electronic phase transitions: superconductivity at T/sub c/apeq21.5 K and a second transition at $T_0$apeq217.5 K. The specific-heat anomaly associated with the transition at $T_0$ has a mean-field BCS-like form which suggests the formation of a charge- or spin-density wave that partially gaps the Fermi surface. Through electrical-resistivity measurements, we have studied the influence of pressure P up to —15.4 kbar on these transitions. For pressures less than 12 kbar, $T_0$ increases linearly at a rate —130 mK/kbar, while T/sub c/ decreases linearly at a rate —95 mK/kbar. The nearly equal but opposite P dependences of $T_0$ and T/sub c/ suggest a competition for electronic density of states at the Fermi level. The resistivity, when normalized to its maximum value rho(T/sub max/), scales as a function of reduced temperature T/T/sub max/(P) from T/sub c/ to well above T/sub max/, except in the immediate vicinity of $T_0$.

20690 **Time-dependent phase transformation in $KTaO_3$:Li.** Kamitakahara, W.A.; Loong, C.h.; Ostrowski, G.E.; Boatner, L.A. (Ames Laboratory, United States Department of Energy, Iowa State University, Ames, Iowa 50011). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 1, 223-227(1 Jan 1987). Contract W-7405-ENG-82;AC05-84OR21400;W-31-109-ENG-38.

After cooling below T = 40 K, neutron Bragg-reflection intensities in a single crystal of $KTaO_3$:Li, with 1.7 mol % Li atoms replacing K atoms, are observed to increase in an unusual time-dependent manner: achieving final values only after several hours, and with two characteristic times at each temperature. A $KTaO_3$ crystal with increased Li concentration and a higher T/sub c/ = 60 K showed similar increases in the Bragg-peak intensities with decreasing temperature, but no unusual time dependence was noted. Cooling the sample with the higher lithium content in an applied electric field suppressed the increases in intensity. The unusual time dependence of the Bragg-peak intensities observed for the sample containing 1.7 mol % Li is suggestive of behavior with some "glasslike" characteristics. Additionally, inelastic neutron-scattering results for this dilute sample confirm that the zone-center transverse-optical phonon is slightly hardened rather than softened by the addition of Li to $KTaO_3$.

20691 **Solute trapping in silicon by lateral motion of {111} ledges.** Aziz, M.J.; White, C.W. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review Letters;* **57**: No. 21, 2675-2678(24 Nov 1986). Contract AC05-84OR21400.

The orientation dependence of the nonequilibrium partition coefficient of Bi in Si at constant solid-liquid interface velocity has been measured. The partition coefficient, measured with pulsed-laser melting techniques on a series of Si wafers cut at 5° increments from (110) through (111) to (001), is sharply peaked at (111) and decreases monotonically with increasing inclination from (111). The results suggest that crystal growth and solute trapping occur by the lateral motion of {111} ledges.

20692 **Ordering at Si(111)/a-Si and Si(111)/$SiO_2$ interfaces.** Robinson, I.K.; Waskiewicz, W.K.; Tung, R.T.; Bohr, J. (AT&T Bell Labs, Murray Hill, New Jersey 07973). *Physical Review Letters;* **57**: No. 21, 2714-2717(24 Nov 1986).

X-ray diffraction has been used to measure the intensity profile of the two-dimensional rods of scattering from a single interface buried inside a bulk material. In both Si(111)/a-Si and Si(111)/$SiO_2$

examples there are features in the perpendicular momentum-transfer dependence which are not expected from an ideal sharp interface. The diffraction profiles are explained by models with partially ordered layers extending into the amorphous region. In the Si(111)/a-Si case there is clear evidence of stacking faults which are attributed to residual 7 x 7 reconstruction.

20693 **Steric interactions in a model multimembrane system: A synchrotron x-ray study.** Safinya, C.R.; Roux, D.; Smith, G.S.; Sinha, S.K.; Dimon, P.; Clark, N.A.; Bellocq, A.M. (Exxon Research and Engineering Company, Annandale, New Jersey 08801;). *Physical Review Letters;* **57**: No. 21, 2718-2721(24 Nov 1986).

We report a high-resolution x-ray study of a model multilayer fluid membrane system in the lyotropic L/sub $\alpha$/ phase of a quaternary microemulsion system. The structure factor exhibits power-law behavior characteristic of a Landau-Peierls system. As a function of intermembrane distance 3.8 nm≦d≦16.3 nm, the exponent eta(d) which describes the algebraic decay of layer correlations is predicted by the model of Helfrich where entropic steric repulsions dominate intermembrane interactions.

20694 **Nuclear electric quadrupole induction of atomic polarization.** Sleator, T.; Hahn, E.L.; Heaney, M.B.; Hilbert, C.; Clarke, J. (Department of Physics, University of California, Berkeley, California 94720). *Physical Review Letters;* **57**: No. 21, 2756-2759(24 Nov 1986).

Precessing nuclear quadrupole moments are observed to induce oscillating electric dipole moments in neighboring atoms. The /sup 35/Cl nuclei of a single crystal of $NaClO_3$ placed between the plates of a capacitor are excited into precession by a rf pulse. After the pulse, the electric polarization induced by the chlorine nuclear quadrupole moments produces a voltage across the capacitor, which is amplified with a dc SQUID. This technique provides information on the location and polarizability of atoms near nuclear quadrupole moments in noncentrosymmetric crystals.

20695 **Superconductivity and phase transitions in compressed Si to 45 GPa.** Erskine, D.; Yu, P.Y.; Chang, K.J.; Cohen, M.L. (Department of Physics, University of California, Berkeley, California 94730 and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Physical Review Letters;* **57**: No. 21, 2741-2744(24 Nov 1986). Contract AC03-76SF00098.

A diamond anvil cell is used to measure the pressure dependence of the superconducting transition temperature T/sub c/ in both primitive hexagonal and hexagonal-close-packed Si up to 45 GPa. The experimental results verify the prediction of superconductivity in HCP Si and the measured curve of T/sub c/ versus pressure is found to be in good qualitative agreement with theory, in contrast to a recent experiment by Lin et al. who claim complete disagreement with theory.

20696 **(00l) x-ray diffraction study of stage 1 $\alpha$ and $\beta$ phases of graphite—CsBi/sub x/.** Yang, M.H.; Eklund, P.C. (Department of Physics and Astronomy, University of Kentucky, Lexington, Kentucky 40506). *Journal of Materials Research;* **1**: No. 6, 827-831(Nov 1986).

Results are reported of (00l) x-ray studies of the $\alpha$(I/sub c/ = 10.65 A) and $\beta$(I/sub c/ = 11.49 A) phases of stage 1 graphite—CsBi/sub x/ ternary intercalation compounds that are air stable. The integrated intensities of the (00l) x-ray lines are analyzed in terms of a centrosymmetric sandwich model that consists of two layers each of Cs, Bi, and C. The results of these analyses indicate that the Bi layers are nearly centered in the cell as suggested by Lagrange et al. [Synth. Met. 12, 201 (1985)]. Furthermore, stoichiometries of the $\alpha$ and $\beta$ phases are found to be Cs/sub 0.99/Bi/sub 0.43/$C_4$ and Cs/sub 0.83/Bi/sub 0.81/$C_4$, respectively. The $\beta$ phase is found to contain nearly twice as many Bi atoms. The sample mass change upon intercalation is in good agreement with the x-ray analyses. The substantial difference in the Bi concentration in the $\alpha$ and $\beta$ phases would be expected to have strong influence on the superconducting properties of these graphite intercalation compounds (GIC's).

20697 **Light scattering from oxygen in ZnTe.** Hjalmarson, H.P.; Jones, E.D.; Norris, C.B. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 247-248(15 Aug 1986). (CONF-851185—). Contract AC04-76DP00789.

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

Resonant light scattering experiments and calculations have been performed on substitutional oxygen impurities in ZnTe.

20698 **Effects of porosity on polar backscatter from fiber reinforced composites.** Blodgett, E.D.; Miller, J.G.; Thomas, L.J. (Washington Univ., St. Louis, MO). pp 1267-1274 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

The authors examine the applicability of ultrasonic polar backscatter to the detection and characterization of porosity in fiber reinforced composites. In this technique the insonifying beam is incident on the sample at a non-perpendicular polar angle, so that the specular reflection from the water-composite interface does not dominate the volume backscattered signal. The hypothesis investigated was that the scattering from small voids will be relatively isotropic with respect to the azimuthal angle of incidence, so that the magnitude of variation of the azimuthal bacscatter may be indicative of the porosity. In order to investigate this hypothesis, glass fiber-epoxy composites were fabricated with a range of porosities by the introduction of glass beads from a known size distribution.

20699 **Variations in ultrasonic backscatter attributed to porosity.** Yohas, D.E.; Roberts, R.; Vorres, C.L. (Magnaflox Advanced Research, Elk Grove, IL). pp 1275-1284 of Quantitative nondestructive evaluation Vol. 5B. Thompson, D.O; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This paper presents a detailed look at the nature of the ultrasonic backscatter from graphite epoxy composites. The goal is to define which aspects of the scattered radiation can be quantitively correlated with porosity. The hypothesis underlying this work is that scattering from porosity may be isotropic relative to the more directed scattering of the fibers. This effect is exploited to determine volume fraction of porosity.

20700 **Elastic wave propagation through the interface between two generally anisotropic materials.** Rohklin, S.I.; Adler, L.; Bolland, K. (Ohio State Univ., Columbus, OH). pp 1285-1293 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This paper presents a theoretical discussion of reflection and transmission of ultrasonic waves through bicrystal interfaces in order to approach complex problems. A brief review is presented of the main computational procedure of a unified approach for studying reflection and refraction of elastic waves in general anisotropic media. Two interesting phenomenon are discussed: splitting of the domain of incidence angles into disjoint pieces for certain crystal cuts and strong transformation of incident quasi longitudinal and quasitransverse waves to transmitted pure shear SH waves. This last effect is explained by deviation of displacement vector of incident quasilongitudinal or quasi SV waves from the plane of incidence.

20701 **measurement of electronic effects in semiconductors.** Kino, G.S.; Stearns, R.G. (Stanford Univ., Stanford, CA). pp 963-974 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This paper describes a set of problems that exist in semiconductor fabrication, those associated with the measurement of the electronic properties of semiconductors. The possibility of measuring doping density, implant dosage, and recombination rates, especially the high recombination rates associated with current leakage in semiconductor devices are considered. A number of techniques, largely photoacoustic in nature, are discussed which show promise for the measurement of bulk and surface recombination rates in semiconductors. These techniques also appear to display sensitivity to changes in doping density, although the mechanisms for this sensitivity are not entirely clear at the present time. An example of acoustic wave pertubation experiments is presented in which a silicon sample is illuminated by a modulated laser beam.

20702 **Ultrasonic analysis of thin adhesive bonds.** Pickett, C.A. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN). pp 1309-1314 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This paper describes an investigation that was undertaken at the Oak Ridge Y-12 Plant to determine the cause of amplitude variation that occurs during the ultrasonic inspection of very thin adhesive bonds. The results are discussed and possible future benefits of the work are described. An ultrasonic C-scan of an actual part, illustrating the effect of adhesive thickness variation on the ultrasonic signal is shown and a comparison is made of ultrasonic response.

20703 **Performance of commercial and research grade SiC whiskers in a borosilicate glass matrix.** Gac, F.D.; Petrovic, J.J.; Milewski, J.V.; Shalek, P.D. (Materials Science & Technology Div., Los Alamos National Lab., Los Alamos, NM 87545). pp 978-982 of Proceedings of the 10th annual conference on composites and advanced ceramic materials. Columbus, OH; American Ceramic Society Inc. (1986). (CONF-860152—).

From 10. annual conference on composites and advanced ceramic materials; Cocoa Beach, FL, USA (19 Jan 1986).

Commercial silicon carbide (SiC) whiskers produced in the United States and in Japan, and research grade SiC whiskers grown at Los Alamos by the VLS (vapor-liquid-solid) method were added to a borosilicate glass matrix at a 20 vol% level. The objective of the study was to evaluate the influence of these whiskers on the fabricability, microstructure, and mechanical properties of the composites.

20704 **Improved fiber-reinforced SiC composites fabricated by chemical vapor infiltration.** Stinton, D.P.; Caputo, A.J.; Loweden, R.A.; Besmann, T.M. (Oak Ridge National Lab., Oak Ridge, TN 37831). pp 983-989 of Proceedings of the 10th annual conference on composites and advanced ceramic materials. Columbus, OH; American Ceramic Society Inc. (1986). (CONF-860152—). Contract AC05-84OR21400.

From 10. annual conference on composites and advanced ceramic materials; Cocoa Beach, FL, USA (19 Jan 1986).

Fabrication of fiber-reinforced composites by a patented chemical vapor infiltration process has continued. Modifications to the process used for infiltration of unidirectional preforms resulted in more uniform matrix deposition throughout the preform and improved mechanical properties of the composites. Infiltration of improved cloth preforms containing more uniform porosity resulted in composites with fewer and smaller voids.

20705 **Conduction band energy levels in superlattices with complex unit cells.** Osbourn, G.C. (Sandia National Labs., Albuquerque, NM 87185). pp 219-222 of Layered structures and epitaxy. Gibson, J.M.; Osbourn, G.C.; Tromp, R.M. Pittsburgh, PA; Materials Research Society (1986). (CONF-851217—).

From Materials Research Society meeting; Boston, MA, USA (2 Dec 1985).

The conduction band energy levels and wavefunctions in a number of superlattices with more than two layers per unit cell have been calculated using an effective mass model. Many of these structures exhibit energy levels which can be modeled as resulting from a conventional superlattice with a modified bulk conduction band minimum in the effective wells. These structures should be useful for extending the size of the superlattice periods allowed in strained-layer superlattices.

20706 **Monte Carlo stability analysis of strained layer superlattice interfaces.** Dodson, B.W. (Sandia National Labs., Albuquerque, NM 87185). pp 371-376 of Layered structures and epitaxy. Gibson, J.M.; Osbourn, G.C.; Tromp, R.M. Pittsburgh, PA; Materials Research Society (1986). (CONF-851217—). Contract AC04-76DP00789.

From Materials Research Society meeting; Boston, MA, USA (2 Dec 1985).

The authors have developed a procedure, based on conventional Monte Carlo methods, to investigate the limits of stability of a strained layer superlattice (SLS) system as a function of lattice mismatch and layer thickness. The method is demonstrated by the analysis of two-dimensional Lennard-Jones SLS systems, for which the regime of absolute SLS stability is mapped out. Extension of the technique to three-dimensional silicon-like model systems is discussed, and appropriate model potentials for stability analysis of the Si/SiGe system are introduced.

20707 **Bond alternation in the infinite polyene: effect of long-range Coulomb interactions.** Mazumdar, S.; Campbell, D.K. (Los Alamos National Lab., NM). *Synthetic Metals;* **13**: 163-172(1986).

The authors investigate the effects of long-range Coulomb interactions on bond and site dimerizations in a one-dimensional half-filled band. It is shown that the ground state broken symmetry is determined by two sharp inequalities involving the Coulomb parameters. Broken symmetry with periodicity 2k/sub F/ is guaranteed only if the first inequality (downward convexity of the intersite potential) is obeyed, while the second inequality gives the phase boundary between the bond-dimerized and site-dimerized phases. Application of these inequalities to the Pariser-Parr-Pople model for linear polyenes shows that the infinite polyene has enhanced bond alternation for both Ohno and Mataga-Nishimoto parameterizations of the intersite Coulomb terms. The possible role of distant neighbor interactions in photogeneration experiments is discussed. 26 references, 3 figures.

20708 **Angle-resolved photoemission studies of Ge(111)-c(2 x 8), Ge(111)-(1 x 1)H, Si(111)-(7 x 7), and Si(100)-(2 x 1).** Wachs, A.L.; Miller, T.; Hsieh, T.C.; Shapiro, A.P.; Chiang, T.C. (Univ. of Illinois, Urbana). *Physical Review [Section] B: Condensed Matter;* **32**: No. 4, 2326-2333(15 Aug 1985). Contract AC02-76ER01198.

Angle resolved photoemission measurements have been carried out for Ge(111)-c(2 x 8), Ge(111)-(1 x 1)H, Si(111)-(7 x 7), and Si(100)-(2 x 1) in a normal emission geometry over a wide photon energy range. For Ge(111) and Si(100), dispersive bulk-derived transitions were observed, from which the authors have determined the bulk valence-band dispersion relations for Ge along the [111] direction and for Si along the [100] direction in the Brillouin zone. The results are compared with the theoretical band dispersions of Chelikowsky and Cohen. For Si(111)-(7 x 7), the spectra are dominated by nondispersive features which cannot be used for band mapping. The lack of dispersive bulk-transition features for Si(111)-(7 x 7) is explained in terms of a relatively extended near-surface strain field which renders the electron crystal momentum highly mixed. Several surface-state features on these surfaces were also observed; most of them are visible over a very wide photon energy range and are indeed dispersionless, confirming the previous surface-state assignments. 31 references, 6 figures.

20709 **Measurement of heat transfer through earth in situ.** Blaney, D.L.; Nielsen, C.E. (Dept. of Physics, The Ohio State Univ., Columbus, OH). pp 1227-1231 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

The authors report measurements of heat transfer earth in situ, avoiding the disturbance of soil properties inherent in sampling. Data were taken using a heat source with thermocouples to measure the temperature response of the earth after the source was turned on. Diffusivity and heat capacity was found by fitting a universal solution of the heat conduction equation to the experimental points. The solution is written in a form allowing separate independent evaluation of the two thermal parameters, avoiding need for simultaneous two parameter fitting. An experimental arrangement insensitive to environment thermal perturbations is described, and results obtained are presented.

20710 **Solid electrolyte degradation with applied stress.** Hitchcock, D.C.; de Jonghe, L.C. (Lawrence Berkeley Lab., CA). *Journal of Materials Science Letters;* **4**: 753-754(1985). Contract AC03-76SF00098.

In a recent paper, Kuribayashi and Nicholson reported some results on the effects of an applied mechanical stress on the current density at which electrolytic degradation started for sodium beta-alumina and Nasicon solid electrolytes. Both compressive and tensile stresses were reported to lead to a decrease in the observed critical current density for onset of degradation by crack propagation. The results are remarkable, since they do not agree with what is to be expected when combined mechanical and electrolytic stresses are considered. In this letter they show that applied tensile stresses should reduce the critical current density for failure initiation, while compressive stresses should cause an increase.

20711 **Recent advances in gaseous dielectrics at Oak Ridge National Laboratory.** Christophorou, L.G; Sauers, I.; James, D.R.; Rodrigo, H.; Pace, M.O.; Carter, J.G.; Hunter, S.R. (Oak Ridge National Lab., TN). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Electrical Insulation;* **EI-19**: No. 6, 550-566(Dec 1984).

Recent developments in gaseous dielectrics are discussed with emphasis on dielectric gas mixtures containing $SF_6$. Recent findings on the isotopic, pressure, and nonuniform field dependence of the dielectric strength of gases are also presented, and ways to enhance the corona-stabilization characteristics of gas mixtures by appropriate additives (e.g. to $SF_6$) are outlined. In addition, results are presented on the spark decomposition products of $SF_6$ and the alleviation of the harmful effects of conducting particles by particle coating in situ. Finally, electron attachment, electron drift velocity, and breakdown properties of gas mixtures (e.g. $C_2F_6$ or $C_3F_8$ in Ar or $CH_4$) - comprised of electron attaching and electron conductivity enhancing components - which have promise for use in pulsed power technologies are reported. 73 references, 23 figures, 7 tables.

20712 **Solid-state perspectives of the photoelectrochemistry of semiconductor-electrolyte junctions.** Williams, F.; Nozik, A.J. (Solar Energy Research Institute, Golden, CO). *Nature (London);* **312**: 21-26(1 Nov 1984). Contract AC02-77CH00178.

More than one mechanism is required to account for the photoinduced movement of charge across semiconductor-electrolyte junctions. Distinguishing the various mechanisms, which is here accomplished using a synthesis of theoretical ideas from both solid-state physics and electrochemistry, may have important consequences in research related to potential applications of liquid junction devices in solar energy conversion.

20713 **Critical behavior of the interlayer shear constant in stage 2 K and Rb graphite intercalation compounds.** Hardcastle, S.E.; Neumann, D.A.; Zabel, H.; Rush, J.J. (Univ. of Illinois, Urbana-Champaign). pp 115-117 of Graphite intercalation compounds. Eklund, P.C.; Dresselhaus, M.S.; Dresselhaus, G. (eds.). Pittsburgh, PA; Materials Research Society (1984). Contract AC02-76ER01198.

From 1984 fall meeting of the Materials Research Society proceedings of symposium I; Boston, MA, USA (28-30 Nov 1984).

Layered materials are characterized by a weak interplanar interaction but a strong intraplanar interaction, resulting in a small layer shearing elastic constant $C_{44}$. It has been shown in previous work that the already small elastic constant $C_{44}$ of graphite (~3.5 x $10^{10}$ dynes/cm$^2$ /sup 3-5/) is further reduced upon intercalation with alkali-metal atoms. The most dramatic softening occurs in the stage 2 compounds $KC_{24}$ and $RbC_{24}$, where a reduction by a factor 5 to 10 has been observed, while in the stage 1 compounds $KC_8$ and $CsC_8$ this effect is less pronounced (~30% reduction of $C_{44}$). In the following the authors report on an inelastic neutron measurement of the temperature dependence of $C_{44}$ in the stage 2 compounds $KC_{24}$. A more detailed account of their work will be given elsewhere.

20714 **Fast diffusion of iron in single crystal rutile and iron doped rutile.** Sasaki, J.; Peterson, N.L.; De Jonghe, L.C. (Lawrence Livermore Lab., CA). *Materials Research Society Symposia Proceedings;* **24**: 39-45(1984).

Tracer diffusion coefficients of Fe, D/sub Fe/*, in single crystals of rutile and of 0 -2.0% Fe doped rutile were measured. The oxygen pressure dependence of D/sub Fe/* in pure rutile showed complicated behavior. The values of D/sub Fe/* may consist of contributions from $Fe^{2+}$ ions diffusing by an interstitial mechanism and from $Fe^{3+}$ ions diffusing by an interstitialcy mechanism in cooperation with tetravalent titanium interstitial ions, Ti/sub i// sup ..../. The value of D/sub Fe/* in Fe doped rutile attains a saturation value when the Fe content reaches about 0.1%; D/sub Fe/* decreases drastically when the Fe content exceeds about 0.35%. Complex impedance measurements of electrical conductivity indicate the existence of ionic conduction for Fe doped rutiles containing less than 0.35% of Fe. The small ionic conductivity relative to the values of D/sub Fe/* suggests that only a small fraction of the iron ions are highly mobile. Above 0.35% Fe, the observed drastic decrease in D/sub Fe/* may result from the formation of a shear structure in highly doped rutile. 16 references, 5 figures.

20715 **Ion channeling in elastically strained superlattices.** Barrett, J.H. (Oak Ridge National Lab., TN). *Materials Research Society Symposia Proceedings;* **25**: 465-475(1984). Contract W-7405-ENG-26.

A review is given of the channeling behavior observed in superlattice materials. Elastic strains within the layers have been shown to be the source of the unusual ion dechanneling observed originally in InAs/GaSb and since observed in several other semiconductor superlattices. These strains occur because of the slight mismatch between the lattice constants of the two materials and cause the rows and planes of atoms in the crystal that are inclined to the surface normal to have small directional misalignments at the interfaces between the layers. The effects of these misalignments have been studied by computer simulations of ion trajectories in the crystal and shown to account in a reasonable manner for the observed dechanneling behavior. Calculations have been done as a function of the amount of misalignment to give an indication of how much dechanneling might be expected in other superlattices formed of any pair of materials that have slight mismatches. Various ways of measuring the amount of misalignment have also been studied by simulations and experiments. 27 references, 5 figures.

20716 **Neutron diffraction study on the hyperfine-induced nuclear spin order in the antiferromagnet $PrSn_3$.** Kawarazaki, S.; Kunitomi, N.; Morii, Y.; Suzuki, H.; Moon, R.M.; Nicklow, R.M. (Osaka Univ., Japan). *Solid State Communications;* **49**: No. 12, 1147-1151(1984). Contract W-7405-ENG-26.

At several (h + 1/2 00) reciprocal lattice positions of $PrSn_3$, the authors observed Bragg scattering of neutrons which is purely due to the nuclear spin polarization of $^{141}Pr$, and could measure the temperature dependence of the polarization between 10 mK and 4.2 K. From the perfectly polarized state of the nuclear spins, the difference between the spin-dependent nuclear scattering lengths $b^+$ and $b^-$ has been determined to be $b^+ - b^- = -0.110 +/- 0.006 \times 10^{-12}$ cm, which is significantly larger in magnitude than the previously reported value. An additional electronic polarization which is linearly proportional to the nuclear spin polarization has also been observed. 15 references, 3 figures.

20717 **Ion induced morphological instabilities in Ge.** Appleton, B.R. (Oak Ridge National Lab., TN). *Materials Research Society Symposia Proceedings;* **27**: 195-204(1984). Contract W-7405-ENG-26.

The characteristics of an anomalous morphological instability initiated in amorphous Ge by heavy ion bombardment are reviewed and a model based on defect-production/defect-interactions is proposed. 14 references, 8 figures.

**20718 Electron paramagnetic resonance and relaxation of amorphous silicon below 1 K.** Askew, T.R.; Muench, P.J.; Stapleton, H.J.; Brower, K.L. (Univ. of Illinois, Urbana). *Solid State Communications;* **49**: No. 7, 667-670(1984). Contract AC02-76ER01198;AC04-76DP00789.

Amorphous silicon, generated within crystalline Si by $^{28}Si^{+}$ ion implantation, exhibits an electron spin relaxation rate which varies with temperature as T/sup 2.37/ between 0.3 and 4.2 K. These results exclude the current model of a phonon-limited, direct relaxation mechanism in α-Si. A relaxation process, consistent with the known temperature variation, is outlined. EPR signal strengths, relative to a known paramagnet at temperatures near 1.2 and 0.4 K, put limits on an antiferromagnetic Curie-Weiss temperature of $0 \leqq \text{theta} \leqq 0.06$ K. 13 references, 1 figure.

**20719 Neutron and x-ray diffraction study of the phase transitions in proustite ($Ag_3AsS_3$) between 35 K and room temperature.** Nelmes, R.J.; Howard, C.J.; Ryan, T.W.; David, W.I.F.; Schultz, A.J.; Leung, P.C.W. (Univ. of Edinburgh, Scotland). *Journal of Physics C: Solid State Physics;* **17**: L861-L865(1984). Contract W-31-109-ENG-38.

The techniques of time-of-flight neutron diffraction and high-resolution x-ray diffraction have been used to show that the second-order transition on cooling proustite ($Ag_3AsS_3$) through ~ 61 K is to an incommensurate phase, with a further transition to a commensurate phase at ~ 49 K. 12 references, 2 figures.

**20720 High energy ion beam mixing in $Al_2O_3$.** Lewis, M.B.; McHargue, C.J. (Oak Ridge National Lab., TN). *Materials Research Society Symposia Proceedings;* **27**: 771-776(1984). Contract W-7405-ENG-26.

The ion beam mixing technique has been employed to mix metal atoms into the surface layers of $Al_2O_3$. Ion beams of $Fe^{+}$ and $Zr^{+}$ in the 1 to 4 MeV energy range were used to irradiate $Al_2O_3$ specimens on the surfaces of which films of chromium or zirconium had been evaporated. Some specimens were irradiated at elevated temperatures of 873 or 1173 K. Rutherford backscattering (RBS) and channeling methods were used to measure the metal atom depth profiles near the surface. Analyses of the backscattering data included binary collision calculations using the codes TRIM and MARLOWE. The significance and limitations of high energy (≧ 1 MeV) beams for ion beam mixing experiments is discussed. Evidence was found for radiation enhanced diffusion and/or solubility of zirconium and chromium in $Al_2O_3$ at 873 K. 10 references, 4 figures, 2 tables.

**20721 Disorderly crystal structures in transition metal rich-metalloid alloys: implications for glass formation.** Watson, R.E.; Bennett, L.H. (Brookhaven National Lab., Upton, NY). *Scripta Metallurgica;* **17**: No. 7, 827-832(1983).

Easy glass formation usually occurs near eutectics where the glass forming temperature is close to the melting point. However, as Anderson observed [1], other factors also enter. Citing covalent systems such as $SiO_2$ and $GeS_2$, he noted that glass formation is favored when the crystal structure(s) of the compounds are complicated. The purpose of the present communication is to see what transition metal rich-metalloid compounds have complicated structures and what implications this might have for glass formation.

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**20722 Fluctuations in diffusion reaction systems. I: Adiabatic elimination of transport modes from a mesoscopic N-body system and the Ω-expansion.** Burschka, M.A. (The Rockefeller University, New York, New York 10021). *Journal of Statistical Physics;* **45**: No. 2, 715-744(Nov 1986).

We develop a concise method to compute the corrections to the master equation for chemically reacting systems in particle number space that arise if the system is not a well-stirred tank reactor, but the transport occurs by diffusion. Starting from the master equation in the R/sup N/ space of all reactant particle positions, we expand in inverse powers of the diffusion constant and eliminate all transport modes adiabatically. It is found that the overall effect of spatially nonuniform fluctuations cannot be treated as a mere renormalization of the reaction rate constants. From second order on there appear correction terms with a new structure that corresponds formally to additional virtual reaction paths. An intuitive interpretation along this line is impeded, however, by the formal occurrence of negative reaction rate constants in these terms, i.e., the reaction rate may depend on the concentrations of the final products of the virtual reaction rather than on the ingoing products. We also identify Avogadro's constant as the suitable Ω parameter and extend van Kampen's Ω-expansion systematically, to spatially continuous systems. This secondary expansion then serves to interpret the corrections to the rate equation, and the average and autocorrelation of the density in the stationary state. It is seen that the limits $D \to \infty$ and $\Omega \to \infty$ do not commute. The relevant length and time scales are discussed.

## 4001 Analytical And Separations Chemistry

*REFER ALSO TO CITATION(S) 19987, 19988, 20042, 20048, 20104, 20530, 20647, 20747, 20806, 20862, 20986, 21068, 21071, 21080, 21090, 21157, 21706, 21707*

**20723 (CEA-CONF—8571) Actinides-lanthanides group separation in mixer settler.** Musikas, C.; Vitart, X.; Pasquiou, J.Y.; Hoel, P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Apr 1986. 10p. (CONF-860411—4). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751040.

From 1. international conference on separations science and technology; New York, NY, USA (15 Apr 1986).

Trivalent lanthanides-actinides group separation feasibility using as extractant the mixture tris (2,4,6-(2-pyridyl) 1,3,5-triazine (TPTZ), and dinonylnaphtalene sulfonic acid (HDNNS) in $CCl_4$ was tested in mixer settler counter current. The aqueous phase was 0.125 N $HNO_3$. Encouraging results were obtained but technical problems like slow phases disengagement did not allow to observe the separations factors calculated from batch distribution data. 7 figs., 6 refs.

**20724 (CONF-860911—25) Studies of selected transuranium and lanthanide triiodides under pressure using absorption spectrophotometry.** Haire, R.G.; Young, J.P.; Peterson, J.R.; Benedict, U. (Oak Ridge National Lab., TN (USA); Tennessee Univ., Knoxville (USA). Dept. of Chemistry; Commission of the European Communities, Karlsruhe (Germany, F.R.). European Inst. for Transuranium Elements). 1986. Contract AC05-84OR21400. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004402.

From 192. American Chemical Society national meeting; Anaheim, CA, USA (7 Sep 1986).

The anhydrous triiodides of plutonium, americium, and curium under pressure have been investigated using absorption spectrophotometry. These initial studies on plutonium and curium triiodides together with the published data for americium triiodide show that the rhombohedral ($BiI_3$-type structure) form of these compounds can be converted to the same orthorhombic ($PuBr_3$-type structure) form by applying pressure at room temperature. Absorption spectrophotometry can often differentiate between two crystallographic forms of materials and has been used in the present high pressure studies to monitor the effects of pressure on the triiodides. A complication in these studies of the triiodides is a significant shift of their absorption edges from the near uv to the visible spectral region with pressure. With curium triiodide this shift causes interference with the major f-f absorption peaks and precludes identification by absorption spectrophotometry of the high pressure phase of $CmI_3$. 21 refs., 2 figs.

20725 **(CONF-8609238—1) Ultrasensitive coherent Raman technique with picosecond lasers.** Schauer, M.W.; Pellin, M.J.; Biwer, B.M.; Gruen, D.M. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 4p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87004670.

From 2. international laser science conference; Seattle, WA, USA (20 Sep 1986).

The sensitivity of the Raman-induced Kerr effect is greatly enhanced through the use of picosecond lasers. Experiments in dilute solutions of benzene indicate that sensitivity at the monolayer level is achievable. Applications to transparent media, to fluorescing samples, and to in situ measurements of electrode surfaces are discussed.

20726 **(HMI-B—409) HMI Department of Nuclear Chemistry and Reactor. Scientific report 1983.** (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.). Bereich Kernchemie und Reaktor). 1984. 170p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87751285.

In the reported year of 1983, R and D work was carried out in the following work groups and fields: 1. 'Neutron scattering' (questions of crystal physics for elastic and inelastic neutron scattering, crystal analysis, development work for the extension of BER-II); 2. 'Damage to solids due to radiation' (reactions to failure, atom transport in irradiated materials under mechanical stress, surface effects, materials development for fusion technology etc.); 3. 'Reactor Chemistry' (development and characterization of solidification products for radioactive wastes, induced activity and corrosion of materials for fusion technology, etc.); 4. 'Trace element research in biomedicine' (transport and storage of bioelements in the organism, and related analyses); 5. 'Geochemistry' (geochemistry of reservoirs, trace element distribution and complexing in geochemically relevant systems). Operational and utilization data are given for the BER-II in tables; scientific publications and lectures made members of the institute and by guests are listed.

20727 **(INIS-BR—571) Study for the extraction of uranium from commerical phosphoric acid.** (Sao Paulo Univ. (Brazil)). 1984. 141p. (In Portuguese). NTIS (US Sales Only), PC A07/MF A01. File Number DE87700919.

The extraction of uranium is discribed and for which several parameters such as choice of the extracting agent, uranium oxidation, temperature, phase volume ratio, equilibrium time and number of stages are studied. A synergic mixture constituted by 0,5M DZEHPA/0,125M TOPO in kerosene is used as extracting agent. The uranium extraction is performed by using both batch process and continuous as well as discontinuous counter-current and processes in bench scale. An overall yield of 96% is obtained when the extraction experiment is performed at 45/sup 0/C in a 5-stage continuous extraction process.

20728 **(INIS-BR—572) Use of electrothermal atomization for determining metallic impurities in nuclearly pure uranium compounds.** (Minas Gerais Univ., Belo Horizonte (Brazil)). 1985. 128p. (In Portuguese). NTIS (US Sales Only), PC A07/MF A01. File Number DE87700920.

Atomic absorption spectrometry with electrothermal atomization was used for the determination of Al, Cd, Cr, Fe, Mn, Mo and Ni as impurities in uranium oxide samples. The determinations were performed in solubilized samples both with and without uranium separation as well as in solid samples.

20729 **(IPEN-Pub—91) Spectrographic determination of Nb, Hf, Mo, Ta, Ti, V, W and Zr in uranuim compounds.** (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). Feb 1986. 17p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700936.

A spectrographic method is described for the determination of Nb, Hf, Mo, Ta, Ti, V, W and Zr in uranium compounds. Iron is used both as a coprecipitation agent and as matrix for the spectrographic analysis. The elements are separated from uranium by extraction as the cupferrates with iso-amyl alcohol-chloroform mixture. After evaporation of the solvent and ignition of the residue, Fe/sub 2/O/sub 3/ is added to this residue as much as necessary to complete 20mg and then blended with another 20mg of previously prepared graphite with 8% NaF and 200μg/g Pd. The excitation is carried out in a direct current arc. For 10g of uranium the limits expressed as μg/g are: 0,1 Nb, 0,2 Hf, 0,25 Mo 1,0 Ta, 0,16 Ti, 0,25 V, 1,0 W and 0,60 Zr. The relative standard deviations are in the range from 3,7% to 18% but 37% was attainable only for Ta.

20730 **(IPEN-Pub—99) Spectrographic determination of impurities in beryllium oxide.** (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). Mar 1986. 11p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700938.

A method for the spectrographic determination of Al, B, Cd, Co, Cu, Cr, Fe, Mg, Na, Ni, Si and Zn in nuclear grade beryllium oxide has been developed. The determination of Co, Al, Na and Zn is based upon a carrier distillation technique. Better results were obtained with 2% Ga/sub 2/O/sub 3/ as carrier in beryllium oxide. For the elements B, Cd, Cu, Fe, Cr, Mg, Ni and Si the sample is loaded in a Scribner-Mullin shallow cup electrode, covered with graphite powder and excited in DC arc. The relative standard deviation values for different elements are in the range of 10 to 20%. The method fulfills requirements of precision and sensitivity for specification analysis of nuclear grade beryllium oxide.

20731 **(IPEN-Pub—101) Determination of the O/U ratio in uranium dioxide by gravimetric technique.** (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). Apr 1986. 11p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700939.

In the presente work, the stoichiometric oxygen/metal ratio of uranium dioxide samples was determined by gravimetric method. The method is discussed in detail and the influence of various parameters like humidity and diferent forms of uranium dioxide materials, like pellets and powders, was investigated. For uranium dioxide pellets of same lot of fabrication the precision was 0.2%. The results obtained compare well with other methods.

20732 (NIRS—25, pp 3-4) **Proposal to develop BGO modular cameras for radioisotope imaging in nuclear medicine.** Murayama, H.; Bennett, G.W.; Brill, A.B. (Brookhaven National Lab., Upton, NY). May 1986. NTIS (US Sales Only), PC A06/MF A01. File Number DE87900431.

In National Institute of Radiological Sciences: Annual report, (April 1985-March 1986).

The proposed BGO mosaic detector has immediate applications as a detector unit of a high resolution PET device which offers radionuclide images with potential resolution of less than 2 mm peak width. The two-dimensional BGO modular camera will serve as a unit of a large field-of-view gamma camera, which has the advantage of high count rate performance and high detection efficiency in high energy SPECT, as well as for PET imaging. Such a modular camera offers great flexibility, allowing different geometrical arrangements depending on the clinical applications. These devices could be used as intraoperative tumor localization probes.

20733 **(ORNL/TM—9670) Development of a process flowsheet for the elution of radiocesium from the TMI-2 [Three Mile Island Nuclear Power Station, Unit 2] makeup and purification demineralizers.** Bond, W.D.; Knauer, J.B.; King, L.J. (Oak Ridge National Lab., TN (USA)). Jan 1987. Contract AC05-84OR21400. 47p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005275.

A process was developed for removing radiocesium from the two makeup and purification demineralizers at TMI-2 which had been highly contaminated as a result of the accident in 1979. Process conditions were established in hot-cell experiments using relatively small samples of the contaminated and degraded resins from the TMI-2 demineralizers. The process was designed to elute the radiocesium from the demineralizer resins and then resorb it onto the zeolite ion exchangers contained in the Submerged Demineralizer System (SDS). It was also required to limit the maximum cesium activities in the resin eluates (SDS feeds) so that the radiation field surrounding the pipelines would not be excessive. The process consisted of 17 stages of batch elution. In the initial stage,

the resin was contacted with 0.18 M boric acid. Subsequent stages subjected the resin to increasing concentrations of sodium in $NaH_2BO_3$-$H_3BO_3$ solution (total boron = 0.35 M; and 1 M sodium hydroxide in the final stages). Simulated SDS tests with small zeolite beds (2 mL) showed that the eluates were compatible with SDS processing. Cesium was effectively sorbed (99.99%), and bed performance was unaffected by the presence of relatively small quantities of soluble organic resin degradation products (100 to 200 ppM total C) in the eluates. Also included in this report are radionuclide, elemental, and fissile isotopic analyses of the demineralizer samples, which may be of interest to investigators concerned with the phenomenological aspects of the TMI-2 accidents. 6 refs., 11 figs., 14 tabs.

20734 **(ORNL/TM—10346) Technology assessment for the determination of chemical agent vapors in demilitarization facilities: Final report.** Maskarinec, M.P.; Wise, M.B.; Buchanan, M.V. (Oak Ridge National Lab., TN (USA)). Jan 1987. Contract AC05-84OR21400. 36p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005265.

A survey of analytical methods for the determination of chemical agents GB, VX, and HD was made. HD, or mustard, is bis-2-chloroethyl sulfide, and is classified as a blishtering agent. GB, or Sarin, is isopropyl methyl phosphonofluoridate. VX is O-ethyl-S-(2-diisopropylaminoethyl)methylphosphonothioate. Both GB and VX are nerve agents. Included were methods capable of providing for monitoring requirements at the time weighted average (TWA) and allowable stack concentration (ASC) levels in near real time. A review of the currently used automatic continuous air monitoring system (ACAMS) was made as well as a review of the recently developed atmospheric pressure ionization mass spectrometry (APIMS). This report recommends a strategy for research and development for near term and medium term improvement of the overall monitoring program. 12 refs., 1 tab.

20735 **(PNL-SA—14140) Photon-burst spectroscopy of noble gas metastables for isotopic analysis.** Cannon, B.D.; Whitaker, T.J. (Pacific Northwest Lab., Richland, WA (USA)). Nov 1986. Contract AC06-76RL01830. 7p. (CONF-870132—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003404.

From LASE-13: pulse power for lasers conference; Los Angeles, CA, USA (11 Jan 1987).

We have proposed a novel scheme for isotopic analysis of noble gases. Our calculations indicate that this new technique should be capable of measuring isotope ratios below $10^{-12}$ in samples containing as few as $10^5$ atoms of the minor isotope. This will make possible several applications for noble gas isotopic analysis that have been proposed. They include dating of glaciers and ancient ground water by using $^{81}Kr$, measurement of vertical mixing rates in the ocean using $^{39}Ar$, and many others. An additional virtue of our approach is that it can use either a commercially available dye laser system or an inexpensive and highly reliable AlGaAs diode laser. 6 refs., 4 figs.

20736 **Use of two-photon excitation in resonance ionization mass spectrometry.** Apel, E.C.; Anderson, J.E.; Estler, R.C.; Nogar, N.S.; Miller, C.M. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Applied Optics;* **26**: No. 6, 1045-1050(15 Mar 1987).

We report the detection of a series of elements via 2+1 (photons to resonance+photons to ionize) resonance ionization mass spectrometry. The efficiency of this process is demonstrated, as the two-photon step can often be saturated. Examples are given where experimental observations of ion yields are compared to theoretical calculations based on a simple formalism used for two-photon transition rates, coupled with a rate-equations calculation of the total ionization rate. Advantages of 2+1 ionization compared with more widely used 1+1 processes are discussed.

20737 **Fixture for supporting and aligning a sample to be analyzed in an X-ray diffraction apparatus.** Green, L.A.; Heck, J.L. Jr. (to Dept. of Energy, Washington, DC). US Patent 4,641,329. 3 Feb 1987. Filed date 23 Apr 1985. vp.

This patent describes a fixture for aligning and supporting a sample in a X-ray beam projecting from an X-ray source to an X-ray detector mounted for rotation about a first axis for X-ray diffraction analysis of the sample. It comprises base means rotatable on the first axis and supported at a location intermediate the X-ray beam source and the X-ray detector, first and second plate means carried by and rotatable with the base means and disposed on the base means in a stacked array along the first axis and with juxtaposed planar surfaces disposed perpendicular to the first axis, and yieldable means securing the first plate means to the second plate means for urging the first plate means towards the second plate means. The fixture also comprises a boss means centrally disposed on a surface of the first plate means and extending along the first axis, and sample supporting means movably attached to the boss means for selective movement along the first axis and having an elongated receptable therein extending along the first axis for receiving and supporting a sample-containing capillary on the first axis. A selectively adjustable spacer means tilts the first plate means and the sample supporting means along at least one other axis for positioning and maintaining the sample-containing capillary on the first axis during rotation of the base means.

20738 **Quantitative analysis of boron oxide in borosilicate glasses by infrared spectroscopy.** Haaland, D.M. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Applied Spectroscopy;* **41**: No. 8, 1152-1155(Nov 1986). Contract AC04-76DP00789.

Classical multivariate least-squares methods have been applied to the quantitative analysis of boron oxide in bulk borosilicate glasses using transmission infrared spectroscopy. However, molecular interactions in the glass result in deviation from Beer's law and cause the analytical B-O overtone band at —2680 $cm^{-1}$ to shift to higher energy with increased boron concentration. Therefore, in order to account for the molecular interactions and achieve higher quantitative accuracy, one must use a nonlinear model relating absorbance and concentration. It has been found that if a quadratic correction term is added to the Beer's-law equation, the observed 15 to 25 $cm^{-1}$ shift in frequency of the B-O overtone band can be modeled to within the spectral noise. With the use of a model quadratic in boron oxide concentration, the least-squares analysis of boron in glass was determined with an average relative error of 3.3% for glasses with boron oxide concentrations ranging from 0.88 to 2.58%. This compares favorably with the 3% accuracy claimed for ion chromatography exculsion used for calibration. The methods described in this paper are general, and a variety of nonlinear models can be applied whenever Beer's-law deviations are present.

20739 **Selection and evaluation of internal standard elements based on elemental/instrumental covariance.** Bentley, G.E.; Hamilton, V.T.; Peterson, E.J.; Wangen, L.E. (Chemistry Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Applied Spectroscopy;* **40**: No. 7, 949-953(Sep 1986).

The selection of internal standards for elements analyzed by a multielement direct-current argon plasma emission spectrometer was made by studying the elemental covariance of a mulielement standard. Principal components factor analysis of many analytical determinations of this standard indicated that the elemental covariance clustered into two main groups. These groups were a function of instrumental variation, mainly plasma shape. The first principal factor accounted for 43.4% of the variance and had high loadings for strontium, barium, boron, manganese, nickel, titanium, silicon, calcium, and cadmium. The second principal factor accounted for an additional 36.7% of the variance and had high loadings for lithium, vanadium, magnesium, potassium, and aluminum. Compared with an external standard, internal standards dictated by the principal components factor analysis results gave improved precision. Internal standards not correlated with response variations degraded both the accuracy and the precision of the analysis.

20740 **Investigation of an anion exchange resin for clean-up of a coolant used to machine nuclear materials.** Hinton, E.R. Jr.; Tucker, H.L.; Asbury, W.L. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN). *Analytical Letters;* **19**: No. 21-22, 2121-2129(1986). Contract AC05-84OR21409.

This article describes the interaction of Dowex SBR-P, which is a strongly basic anion exchange resin, with ions found in a

used machining coolant. The coolant is used in machining enriched uranium and contains uranium, chloride, nitrite, borate ions, water, and propylene glycol.

20741 **Evaluation of the continuous optical discharge for spectrochemical analysis.** Cremers, D.A.; Archuleta, F.L.; Martinez, R.J. (Los Alamos National Lab., NM). *Spectrochimica Acta, Part B: Atomic Spectroscopy;* **40B**: No. 4, 665-679(1985).

The continuous optical discharge (COD) has been studied as a spectrochemical excitation source for atomic emission spectroscopy. The COD was generated by focusing a 45-W cw-$CO_2$ laser beam in Xe gas at pressures between 1150 and 3200 torr. The high temperature (10,000 K) and electron density ($\sim 10^{17}$ $cm^{-3}$) of the plasma should provide good excitation for elements difficult to excite by more conventional sources. Some characteristics of the plasma were examined as a function of laser power and gas pressure. The design of a gas cell for analytical measurements which increases plasma stability is presented. Linear calibration curves for $O_2$ and $Cl_2$ introduced into the plasma were obtained and detection limits established. Detection limits were also determined for solid materials laser ablated into the COD. Because the COD operates at pressures above atmospheric, gas samples are most easily introduced for analysis. To prevent contamination of optical components by analyte dissociation products, the COD should be operated as a plasmatron. 43 references, 8 figures, 4 tables.

## 4002 Inorganic, Organic And Physical Chemistry

*REFER ALSO TO CITATION(S) 19904, 20163, 20616, 20786, 20788, 20795, 21010, 21098, 21099, 21166, 21182, 21447*

20742 **(AD-A—175586/7/XAB) Self-reaction of HO(2) and DO(2): negative temperature dependence and pressure effects. Progress report, 1 July-31 December 1985.** Mozurkewich, M.; Benson, S.W. (University of Southern California, Los Angeles (USA). Loker Hydrocarbon Research Inst.). 1985. 23p. NTIS, PC A02/MF A01.

Published in International J. of Chemical Kinetics, Vol. 17, 787-807(1985).

The negative temperature dependence, pressure dependence, and isotope effects of the self-reaction of $HO_2$ are modeled, using RRKM theory, by assuming that the reaction proceeds via a cyclic, hydrogen-bonded intermediate. The negative temperature dependence is due to a tight transition state, with a negative threshold energy relative to reactants, for decomposition of the intermediate to products. A symmetric structure for this transition state reproduces the observed isotope effect. The weak-pressure dependence for the $DO_2$ self-reaction is due to the approach to the high-pressure limit. Addition of a polar collision partner, such as ammonia or water intermediate is discussed. A detailed model is presented to fit the data for these effects. Large ammonia concentrations should make it possible to reach the high-pressure limit of the self-reaction of $HO_2$.

20743 **(AD-A—175627/9/XAB) Test of variational transition-state theory and multidimensional semiclassical transmission coefficient methods against accurate quantal rate constants for H + $H_2$/HD, D + $H_2$, and O + $H_2$/$D_2$/HD, including intra- and intermolecular kinetic isotope effects.** Garrett, B.C.; Truhlar, D.G.; Schatz, G.C. (Chemical Dynamics Corp., Upper Marlboro, MD (USA)). 1986. 8p. NTIS, PC A02/MF A01.

Published in J. of the American Chemical Society, Vol. 108, No. 11, 2876-2881(1986).

Rate constants and kinetic isotope effects for the title reactions were calculated using accurate quantum-dynamical methods, and used to test the accuracy of corresponding rate constants from conventional and variational transition-state theory. The quantum-dynamical rate constants are estimated to be within 35% of the exact rate constants for the potential energy surfaces chosen for this comparison. For all the reactions considered, the conventional and variational transition-state theory rate constants with unit transmission coefficient are found to be very close to each other (better than 7%), but in poor agreement with the accurate quantum results (off by factors of 6-22 at 300K). This indicates that although variational effects are small, tunneling makes a very important contribution to the rate constants, and it is found that the tunneling contribution is described quantitatively for all the reactions considered using the least-action ground state (LAG) transmission coefficient. The combination of improved canonical variational theory (ICVT) and LAG yields rate constants that have an average error (considering all the reactions and temperatures studied) of only 15% compared to the accurate quantal rate constants, and in only one case (D + $H_2$ at 200K) does the ICVT/LAG rate constant differ by more than 35% from the accurate value. The comparison of ICVT/LAG kinetic isotope effects is found to be similarly good, with worst comparisons occurring for intramolecular (X+HD) isotope ratios.

20744 **(AD-A—175628/7/XAB) Ab initio predictions and experimental confirmation of large tunneling contributions to rate constants and kinetic isotope effects for hydrogen-atom transfer reactions.** Garrett, B.C.; Truhlar, D.G.; Bowman, J.M.; Wagner, A.F.; Robie, D. (Chemical Dynamics Corp., Upper Marlboro, MD (USA)). 1986. 4p. NTIS, PC A02/MF A01.

Published in J. of the American Chemical Society, Vol. 108, 3515-3516(1986).

The importance of tunneling in gas-phase hydrogen-atom transfer reactions is investigated. New experimental measurements and theoretical calculations are presented for the intramolecular kinetic isotope effect $K_3K_4$. This new information and earlier results for the reaction rate constants for the O + $H_2$ and O + $D_2$ reactions provide strong evidence for the dominance of tunneling in all four reactions at temperatures below 500K. Three theoretical approaches are used: the improved canonical variational theory with classical reaction coordinate motion (ICVT), ICVT with least-action ground-state transmission coefficients to account for tunneling (ICVT/LAG), and the reduced-dimensionally quantum calculations with an adiabatic incorporation of bending motion (denoted more specifically as collinear exact quantum with ground-state bend or CEQB/G). All calculations use an accurate ab initio potential energy surface. In general the agreement is good between the ICVT/LAG and CEQB/G calculations and the experimental results. Although the ICVT results (which neglect tunneling effects) are accurate at high temperatures (1400-1900K), they are inconsistent with the experimental results temperatures (318-500K) indicating that tunneling is important. The LAG method also provides a measure of the importance of tunneling for this reaction: the percentage of the reaction that occurs by tunneling. For the O + $H_2$ reaction, this factor is 94% and 76% at 300 and 400K, respectively.

20745 **(CONF-8608157—1) On the conformal ionic solution theory: Principles and applications.** Saboungi, M.L. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004946.

From Advanced study institute on molten salt chemistry; Camerino, Italy (3 Aug 1986).

An overview of the conformal ionic solution (CIS) theory is presented with special emphasis on applications of the derived equations to practical problems. The principles of the theory, the derivation of the equations, and the theoretical extension to multicomponent ionic systems are briefly discussed. A variety oe examples is given to illustrate the use of this theory in practical problems, e.g., a priori calculations of phase diagrams and of other thermodynamic properties of ternary and higher order molten salt systems and of solubility products. 19 refs., 4 figs.

20746 **(INPE—3894) Isotopic enrichment in a plasma centrifuge.** (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). May 1986. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700928.

A rotating fully ionized plasma column was produced in a vacuum-arc centrifuge. The apparatus is described and new results for the rotational velocity and isotope enrichment of carbon and metal plasmas are shown. The ion rotation velocity is derived from electrostatic probes measurements and from the azimuthal displacement of the material deposited behind a narrow slit. The isotope enrichment is measured with a modified quadrupole mass spectrome-

ter, which determines, in situ, the relative abundance of the isotopes at the end of the plasma column at various radial positions.

**20747 (LA-UR—86-4135) Detection of transient fluorine atoms.** Loge, G.W.; Nereson, N.; Fry, H.A. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 5p. (CONF-861038—4). NTIS, PC A02/MF A01; GPO Dep. File Number DE87003723.

From OSA/APS international laser science conference; Seattle, WA, USA (20 Oct 1986).

A KrF eximer laser with a fluence of 50 mJ/cm$^2$ was used to photolyze either uranium hexafluoride or molecular fluorine, yielding a transient number density of fluorine atoms. The rise and decay of the atomic fluorine density was observed by transient absorption of a 25-μm Pb-salt diode laser. To prevent the diode laser wavelength from drifting out of resonance with the atomic fluorine line, part of the beam was split off and sent through a microwave discharge fluorine atom cell. This allowed a wavelength modulation-feedback technique to be used to lock the diode laser wavelength onto the atomic line. The remaining diode laser beam was made collinear with the eximer laser beam using a LiF window with a 45° angle of incidence to reflect the infrared beam while transmitting most of the uv beam. Using this setup along with a transient digitizer to average between 100 and 200 transient absorption profiles, fluorine atom number densities on the order of $10^{14}$ cm$^{-3}$ in a 1.7 m pathlength were detected. The signals observed were about a factor of two less than expected from known photolysis and atomic fluorine absorption cross-sections. 2 refs., 4 figs.

**20748 (LBL—22535) Synthesis and characterization of (pentamethylcyclopentadienyl)iridium polyhydride and polyphosphine complexes.** Gilbert, T.M. (California Univ., Berkeley (USA). Dept. of Chemistry). Jul 1985. Contract AC03-76SF00098. 265p. NTIS, PC A12/MF A01; 1; GPO Dep. File Number DE87004597.

Results of investigations in the following areas of research are reported: trimethylphosphine-substituted (pentamethylcyclopentadienyl)iridium complexes; protonation and deprotonation of $(C_5(CH_3)_5)Ir(P(CH_3)_3)H_2$; synthesis and characterization of poly-trimethylphosphine-(pentamethylcyclopentadienyl)iridium complexes; simulation of "virtually coupled" $^{13}C$ NMR spectra of $(C_5R_5)M(P(CH_3)_3)$/sub x/ L/sup n+/ species; preparation and reactions of tetrahydrido(pentamethylcyclopentadienyl)iridium: a novel iridium (V) polyhydride; (pentamethylcyclopentadienyl)iridium polyhydride complexes: synthesis of intermediates in the mechanism of formation of $(C_5(CH_3)_5)IrH_4$ and the preparation of several iridium (V) compounds; NMR spectra of $(C_5(CH_3)_5)IrH_2SiMe_3Li$(pmdeta) and $(C_5(CH_3)_5)IrH_3Li$ (pmdeta): the first direct observation of resolved $^7Li$ - $^1H$ coupling. 116 refs., 13 figs., 9 tabs.

**20749 Intramolecular energy transfer in the HNC/HCN isomerization reaction: Quasiclassical state specific isomerization rates controlled by localized potential features.** Smith, R.S.; Shirts, R.B.; Patterson, C.W. (Los Alamos National Laboratory, T-12, Mail Stop J569, Los Alamos, New Mexico 87545 and Department of Chemistry, University of Utah, Salt Lake City, Utah 84112). *Journal of Chemical Physics;* **86**: No. 8, 4452-4460(15 Apr 1987).

A model of the HCN molecule with two degrees of freedom, consisting of the H—NC stretch and the H—NC bend with the CequivalentN distance held fixed, was studied. The semiclassical technique of adiabatic switching was used to obtain trajectories at eigenvalues of metastable states of the system. Quasiclassical results for the isomerization rate from HNC to HCN at various stretch and bend excitations are given. Results show that the isomerization rate is highly dependent on the bend excitation and less so on the total energy of the system in contradiction to predictions of statistical theories. Examination of individual trajectories and surfaces of section reveal the development of chaos near the N/sub bend/ = 6 level. The development of chaos is apparently responsible for the energy transfer between the modes and thus the isomerization rate. Examination of the potential surface reveals a distinct topological change near the N/sub bend/ = 6 level. The region responsible for energy transfer is identified, and the possible mechanisms for this transfer are enumerated.

**20750 Calculation of the tortuosity factor in single-phase transport through a structured medium.** Lee, P.H.; Kozak, J.J. (Department of Chemistry and Radiation Laboratory, University of Notre Dame, Notre Dame, Indiana 46556). *Journal of Chemical Physics;* **86**: No. 8, 4617-4627(15 Apr 1987).

In this paper we explore the interplay between the tortuosity factor and the porosity in influencing single-phase transport through porous media. We design a capillary model which incorporates features of both parallel and serial arrays of channels and calculate the first moment (the mean walklength) of the stochastic distribution function describing the passage of a permeant across the medium as a function of system size, boundary conditions, the surface density of entry and exit sites, and the internal structure of the medium. We show that for a porous medium with multiple entry/exit sites and a given specific permeability, the tortuosity factor increases monotonically with respect to the porosity (starting from a completely channeled flow), passes through a maximum, and then decreases with increase in porosity (to the limiting case of an entirely unrestricted flow). In the special case where the flow from the porous media is constricted (limited to a single exit channel), the tortuosity is found to be a strictly monotonically decreasing function of the porosity.

**20751 Statics and dynamics of concentration fluctuations in nonionic micellar solutions.** Wilcoxon, J.P.; Kaler, E.W. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Chemical Physics;* **86**: No. 8, 4684-4691(15 Apr 1987). Contract AC04-76DP00789.

Measurements of the angular distribution of light scattered from a nonionic surfactant, $C_{12}E_6$, are used to obtain the divergence of the static correlation length and isothermal compressibility near the critical point. The dependence of the apparent diffusion coefficient on momentum transfer yields a dynamic correlation length which agrees closely with the static values for the temperature regime (T/sub c/-4 °C)<T<T/sub c/. Outside this regime the scattering measurements are consistent with micelle growth. Dynamic scaling holds for this system near T/sub c/ but a significant background contribution to the diffusion coefficient is present due to the large micelle size.

**20752 MNDO barrier heights for catalyzed bicycle-pedal, hula-twist, and ordinary cis-trans isomerizations of protonated retinal Schiff base.** Seltzer, S. (Brookhaven National Lab., Upton, NY). *Journal of the American Chemical Society;* **109**: No. 6, 1627-1631(18 Mar 1987).

Energy barriers to dark cis-trans isomerization in a protonated retinal Schiff base model in the presence and absence of electrostatic and nucleophilic catalysts have been calculated by the MNDO method. Three general processes - ordinary double bond isomerization, concerted isomerization about two double bonds by bicycle-pedal motion, and one-step double bond and adjacent single bond isomerization by hula-twist motion - are considered. Point negative charges or negatively charged nucleophiles near the protonated nitrogen substantially increase the barrier to cis-trans isomerization over what they would be in the absence of these agents. Negative charge or a nucleophile near C13 lowers the barrier to bicycle-pedal isomerization. Dark isomerization by a hula-twist motion required greater energy and is not substantially aided by the placement of a negative charge or nucleophile near any of the skeletal atoms in the isomerizing system. The importance of this to the mechanism of dark-light adaptation of bacteriorhodopsin is discussed.

**20753 Size quantization in layered semiconductor colloids with tetrahedral bonding: $HgI_2$.** Micic, O.I.; Nenadovic, M.T.; Peterson, M.W.; Nozik, A.J. (Boris Kidric Institute of Nuclear Sciences, Beograde, Yugoslavia). *Journal of Physical Chemistry;* **91**: No. 6, 1295-1297(12 Mar 1987).

Small-particle-size colloids of red $HgI_2$ show relatively sharp blue-shifted optical absorption peaks in the UV that are attributed to size quantization effects. Within the framework of a simple model that only considers transitions between the lowest quantum states of electrons and holes in $HgI_2$, the optical data are consistent with crystallite structures containing up to four $HgI_2$ layers with

dimensions in the layer plane ranging from 10 to 26 A. The lowest two energy peaks could not be accommodated by particles containing only a single layer of $HgI_2$. Published data on layered $PbI_2$ colloids are also believed to be incompatible with a single $PbI_2$ layer if more acceptable values of the effective masses for electrons and holes in $PbI_2$ are used in the analysis. Preliminary calculations indicate that the optical data are also consistent with a single particle size showing multiple transition between higher energy quantum levels of electrons and holes. The possible existence of magic number in $HgI_2$ colloids is inconclusive based on the optical data and electron microscopy.

20754 **Time-resolved emission at the glass-to-fluid transition. Localization or delocalization in polypyridyl-based metal-to-ligand charge-transfer excited states of ruthenium and osmium?.** Danielson, E.; Lumpkin, R.S.; Meyer, T.J. (Univ. of North Carolina, Chapel Hill). *Journal of Physical Chemistry;* **91**: No. 6, 1305-1306(12 Mar 1987). Contract AS05-78ER06034.

The time dependence of MLCT excited-state emission for $[Os(phen)(das)_3]^{2+}$ in the glass-to-fluid transition region in 4:1 ethanol-methanol is analogous to that observed earlier for $[Ru(bpy)_3]^{2+}$. This observation calls into question the earlier suggestion that the origin of the time dependence in the emission spectrum of $Ru(bpy)_3^{2+}$ is a delocalized, $[Ru(bpy^{-1}/3)_3]^{2+*}$, to localized, $[(bpy)_2Ru(bpy^-)]^{2+}$ I, transition. In the osmium complex the time-dependent shifts to lower energy are proposed to arise from a dynamic solvent effect involving solvent dipole reorientations.

20755 **Electronic spectrum of thioketene and the excited-state structure of ketene.** Clouthier, D.J. (Univ. of Kentucky, Lexington). *Journal of Physical Chemistry;* **91**: No. 6, 1354-1357(12 Mar 1987). Contract FG05-86ER13544.

The electronic absorption spectra of thioketene-$h_2$ and -$d_2$ in the gas phase have been observed for the first time. Although rotationally diffuse, the spectra are vibronically discrete and analysis suggests an in-plane bent excited-state structure. The results are correlated with previous experimental and theoretical work on ketene.

20756 **Comparison of the harmonic and morse oscillator models in He + $I_2$ collisions using the vibrational/rotational infinite-order sudden approximation.** Eggert, S.; Tellez, S.; Pfeffer, G.A. (Univ. of Nebraska, Omaha). *Journal of Physical Chemistry;* **91**: No. 6, 1414-1423(12 Mar 1987).

The recently developed vibrational/rotational infinite-order sudden approximation (VRIOSA) has been used to investigate the effect of the oscillator model for the diatomic molecule upon He and $I_2$ collisions at energies ranging from 0.044 to 0.5 eV. The two models used were the harmonic and Morse oscillators; integral and differential cross sections for vibrational transitions from $0 \rightarrow 0$, 1, 2, or 3 and for rotational transitions from $0 \rightarrow 0$, 10, 20, 30, 40, 50, and 60 have been calculated with both models. The results of these two oscillators are compared to each other, to vibrational close-coupled infinite-order sudden approximation (VCC-IOSA) results obtained with the Morse oscillator, and to experimental results. The present work extends the previous oscillator comparisons by employing a three-dimensional quantum formalism, by considering a large array of rotational and vibrational transitions, by including the differential cross sections and an experimentally obtainable cross section, and by focusing on a non-hydrogen-containing diatomic molecule. The VRIOSA is also advantageous for these studies under certain conditions. In general, the two oscillator models agree well when the vibrational quantum number change is small and when the energy is high. In addition, the more highly averaged the cross sections, the more closely the models agree with one another. However, for some transitions and values of the scattering angle, there are differences of orders of magnitude in the differential cross sections. In this study, the effect of a change in the oscillator wave function upon the cross sections was larger than the effect of a change in the oscillator energy levels.

20757 **Bonding and thermal decomposition of propylene, propadiene, and methylacetylene on the Rh(111) single-crystal surface.** Bent, B.E.; Mate, C.M.; Crowell, J.E.; Koel, B.E.; Somorjai, G.A. (Lawrence Berkeley Lab., CA). *Journal of Physical Chemistry;* **91**: No. 6, 1493-1502(12 Mar 1987). Contract AC03-76SF00098.

The reactions of propylene, propadiene, and methylacetylene with Rh(111) crystal faces in ultrahigh vacuum (UHV) from 80 to 800 K have been studied by low-energy electron diffraction (LEED), high-resolution electron energy loss spectroscopy (HREELS), and thermal desorption spectroscopy (TDS). All three hydrocarbons adsorb intact at 80 K. At this temperature, methylacetylene forms a p(2 x 2) LEED pattern while propylene and propadiene adsorb as disordered monolayers. Above 200 K, propylene and propadiene also form p(2 x 2) LEED patterns which are stable up to 270 K. The propylene fragment in this temperature range is propylidyne ($CCH_2CH_3$). By room temperature all the $C_3$ hydrocarbons have decomposed to ethylidyne ($CCH_3$) and polymerized C/sub x/H fragments. Surface hydrogen is instrumental in the C-C bond breaking, and partial deuteriation studies were performed to determine which C-C bonds break first. The ethylidyne species are stable up to 400 K, above which they decompose to C/sub x/H fragments. The bonding and the thermal decomposition pathways for propylene on Rh(111) are compared to Pt(111) surface chemistry.

20758 **Structure, interaction, and growth of sodium dodecyl-o-xylenesulfonate micelles in aqueous solutions.** Sheu, E.Y.; Chen, S.H.; Huang, J.S. (Massachusetts Institute of Technology, Cambridge). *Journal of Physical Chemistry;* **91**: No. 6, 1535-1541(12 Mar 1987).

The small-angle neutron scattering (SANS) technique was used to study the structure and interaction between micellar aggregates formed from an anionic surfactant, sodium dodecyl-o-xylenesulfonate, in aqueous solutions. In the range of monomer concentrations studied, namely, from 0.25 to 5 wt %, the intermicellar interaction was significant and the nonideality effect needs to be explicitly taken into account in the data analysis. The basic structural parameters of the micelle were determined at a low concentration by a contrast variation method at finite Q (Q is the magnitude of the scattering vector). The same set of basic parameters were then used as the input to study the growth and interaction of the micelles at higher concentrations and at different temperatures. The minimum micellar aggregate near cmc is found to be spherical with an aggregation number of 30. The aggregation number increases steadily at higher concentrations and the shape of the aggregates become prolate spheroidal. The interparticle structure factor was computed by solving a primitive model two-component Coulomb fluid in a mean spherical approximation. The effective charge of the micelle extracted from SANS experiment can be interpreted as the dressed charge they discussed in their previous paper.

20759 **Structure of high-density water at constant temperature.** Pettitt, B.M.; Calef, D.F. (Univ. of Houston, TX). *Journal of Physical Chemistry;* **91**: No. 6, 1541-1545(12 Mar 1987).

Calculations of the site-site correlation functions for a model of water were performed as a function of density (or pressure) at fixed temperature. These calculations are discussed and compared to neutron-scattering data. The structure of liquid water at high pressure is consistent with a substantially distorted hydrogen-bonding network. It is found that, unlike MeOH, water cannot easily accommodate structures associated with directional attractive forces in the region of several kilobars of pressure.

20760 **High-temperature photochemistry kinetics study of the reaction of $O(^3P)$ atoms with ethylene from 290 to 1510 K.** Mahmud, K.; Marshall, P.; Fontijn, A. (Rensselaer Polytechnic Institute, Troy, NY). *Journal of Physical Chemistry;* **91**: No. 6, 1568-1573(12 Mar 1987). Contract FG02-84ER13224.

The $O + C_2H_4$ reaction has been investigated in a high-temperature photochemistry (HTP) reactor at temperatures from 290 to 1510 K and pressures from 60 to 500 Torr. Ground-state O atoms were generated by flash photolysis of $CO_2$ and monitored by time-

resolved atomic resonance fluorescence with pulse counting. Measurements were made under pseudo-first-order conditions [O] << [$C_2H_4$]. Rate coefficients from 290 to 850 K are in good agreement with the numerous earlier measurements in that range. Above those temperatures a sharp rise in k(T) with increasing T is evident. On the basis of present and other measurements by isolated elementary reaction techniques they recommend $k(T) = 1.3 \times 10^{-11} \exp(-830 K/T) + 1.9 \times 10^{-9} \times \exp(-6940 K/T)$ $cm^3$ $molecule^{-1}$ $s^{-1}$ as a fit expression for the 290-1510 K range. Confidence limits are discussed in the text. It is shown that the accepted transition-state treatment for channels significant at T < 850 K cannot account for the sharp upward curvature. Other channels will have to be considered at higher temperatures.

**20761 Direct rate constant measurements for the reaction of ground-state atomic oxygen with ethylene, 244-1052 K.** Klemm, R.B.; Nesbitt, F.L.; Skolnik, E.G.; Lee, J.H.; Smalley, J.F. (Brookhaven National Lab., Upton, NY). *Journal of Physical Chemistry;* **91**: No. 6, 1574-1580(12 Mar 1987). Contract AC02-76CH00016.

The rate constant for the reaction of ground-state atomic oxygen with ethylene was determined by using two techniques: flash photolysis-resonance fluorescence (FP-RF, 244-1052 K) and discharge flow-resonance fluorescence (DF-RF, 298-1017 K). Kinetic complications due to the presence of molecular oxygen in the FP-RF experiments at high temperatures (T > 800 K) were overcome by using NO as the photolytic source of the O atoms. The rate constant, $k_1$ (T), derived in this study exhibits extreme non-Arrhenius behavior, but it can be successfully fit to the sum of exponentials expression, 244-1052 K, $k_1(T) = (1.02 +/- 0.06) \times 10^{-11} \exp(-753 +/- 17 K/T) + (2.75 +/- 0.26) \times 10^{-10} \exp(-4220 +/- 550 K/T)$, in units of $cm^3$ $molecule^{-1}$ $s^{-1}$. Additionally, a fit of the results of this work to a simple transition-state theory expression and the comparison of these results with those of other workers are discussed.

**20762 One-electron-transfer reactions of the couple $SO_2$/$SO_2^-$ in aqueous solutions. Pulse radiolytic and cyclic voltametric studies.** Neta, P.; Huie, R.E.; Harriman, A. (National Bureau of Standards, Gaithersburg, MD). *Journal of Physical Chemistry;* **91**: No. 6, 1606-1611(12 Mar 1987).

Rate constants for one-electron reduction of $SO_2$ by several radicals and for reduction of several compounds by $SO_2$/sup .-/ radicals were determined by pulse radiolysis at pH 1. $SO_2$ is reduced by the $(CH_3)_2COH$ radicals with $k = 2.1 \times 10^9$ $M^{-1}$ $s^{-1}$ and by viologen radicals and certain porphyrin $\pi$-radical anions with $k \sim 10^8$-$10^9$ $M^{-1}$ $s^{-1}$. The $SO_2$/sup .-/ radical reduces compounds which have reduction potentials more positive than -0.28 V. The rate constants for these reductions vary from $< 10^7$ to $> 10^9$ $M^{-1}$ $s^{-1}$ and depend on the redox potentials of the compounds and on other properties such as charge and self-exchange rate. The reduction potentials for $SO_2$ and for the porphyrins were determined by cyclic voltametry under identical conditions. These reduction potentials were used along with the rate constants and previously reported self-exchange rates to estimate the self-exchange rate for the couple $SO_2$/$SO_2$/sup .-/ in acidic solutions. The calculated values were found to vary over many orders of magnitude, similar to the situation reported before for the $O_2/O_2^-$ couple.

**20763 Thermochemistry of the gaseous uranium bromides UBr through $UBr_5$.** Lau, K.H.; Hildenbrand, D.L. (SRI International, Menlo Park, California 94025). *Journal of Chemical Physics;* **86**: No. 5, 2949-2954(1 Mar 1987).

High temperature gaseous equilibria involving the molecular species UBr, $UBr_2$, $UBr_3$, $UBr_4$, and $UBr_5$ were studied by mass spectrometry over wide temperature ranges; reaction enthalpy data were derived primarily from second-law analysis. From this information, the individual bond dissociation energies and the standard enthalpies of formation of the U—Br species were derived with an accuracy of about 8 kJ $mol^{-1}$. The derived bond dissociation energies at 298 K in kJ $mol^{-1}$ are as follows: D °(U—Br) = 377; D °(BrU—Br) = 435; D °($Br_2$U—Br) = 430; D °($Br_3$U—Br) = 348; and D °($Br_4$U—Br) = 166. Trends in these values are similar to those found in the U—Cl system, but quite different from those of the U—F system. Absolute entropies evaluated from the equilibrium data indicate significant electronic contributions for the lighter species, decreasing markedly on approaching $UBr_5$. Trends in the bond dissociation energies and electronic entropies of the fluorides, chlorides, and bromides are discussed.

**20764 Theoretical investigation of Na and Mg atom complexes with $H_2O$.** Curtiss, L.A.; Kraka, E.; Gauss, J.; Cremer, D. (Argonne National Lab., IL). *Journal of Physical Chemistry;* **91**: No. 5, 1080-1084(26 Feb 1987).

The structures, energetics, and vibrational frequencies of the Na...$OH_2$ and Mg...$OH_2$ complexes have been examined by ab initio molecular orbital methods including the effects of electron correlation by Moeller-Plesset perturbation theory. The Na...$OH_2$ complex is predicted to be nonplanar with a Na...O distance of 2.343 A and an energy of dissociation into Na and $H_2O$ of 7.37 kcal/mol. The Mg...$OH_2$ complex is predicted to be nonplanar with a Mg...O distance of 2.321 A and a dissociation energy of 3.82 kcal/mol. Correlation effects are found to be necessary to obtain significant binding between Mg and $H_2O$. The chemical bonding is analyzed in terms of one-electron densities. Considerable charge polarization of the electron density on the metal atom is found.

**20765 Dipositive dimeric ion $Hg_22i$: a theoretical study.** Neisler, R.P.; Pitzer, K.S. (Lawrence Berkeley Lab., CA). *Journal of Physical Chemistry;* **91**: No. 5, 1084-1087(26 Feb 1987). Contract AC03-76SF00098.

Various properties of $Hg_2^{2+}$ (g) are calculated from relativistic quantum mechanics. For comparison, calculations are also made on a nonrelativistic basis. The relativistic values of R/sub e/ and omega/sub e/ agree well with observed values in those crystals or solutions where the effects of surroundings are expected to be small. The relativistic effect reduces R/sub e/ by 0.28 A, raises omega/sub e/ by 67 $cm^{-1}$, and increases D/sub e/ by 24 kcal x $mol^{-1}$. A modified Born-type calculation is carried out for the hydration energy which recognizes the quadrupole moment and the nonspherical shape. Good agreement is obtained with experimental thermodynamic data for aqueous $Hg_2^{2+}$.

**20766 Interfacial tensions and phase behavior of alcohol-hydrocarbon-water-sodium chloride systems.** Puig, J.E.; Hemker, D.L.; Gupta, A.; Davis, H.T.; Scriven, L.E. (Univ. of Minnesota, Minneapolis). *Journal of Physical Chemistry;* **91**: No. 5, 1137-1143(26 Feb 1987).

The phase behavior and interfacial tensions of mixtures of alcohol, alkane, water, and sodium chloride that split into two or three liquid phases at 25°C are reported as a function of type of alcohol and alkane and sodium chloride concentration. The patterns of phase and tension behavior are similar to those observed with surfactant-based microemulsion systems but in a higher tension regime. The qualitative patterns of phase and tension behavior in the alcohol systems appear to be characteristic of all amphiphile-oil-brine systems, although the magnitudes of the interfacial tensions of microemulsion against oil-rich or water-rich phases can be some hundredfold smaller than the corresponding tensions of the alcohol-rich phase against oil-rich or water-rich phases. This difference appears to be a distinguishing feature of microemulsions and presumably arises from the relatively large scale of microemulsion microstructure. Microemulsions in multiphase equilibria incorporate tenfold or more water or oil than do corresponding alcohol solutions, and this argues for the topology and persistence of that microstructure.

**20767 Hydrogen-atom abstraction from alkanes by OH. 6. Cyclopentane and cyclohexane.** Droege, A.T.; Tully, F.P. (Sandia National Labs., Livermore, CA). *Journal of Physical Chemistry;* **91**: No. 5, 1222-1225(26 Feb 1987).

Absolute rate coefficients for the reactions of the hydroxyl radical with cyclopentane-$h_{10}$ ($k_1$), cyclopentane-$d_{10}$ ($k_2$), cyclohexane-$h_{12}$ ($k_3$), and cyclohexane-$d_{12}$ ($k_4$) were determined by the laser photolysis/laser-induced fluorescence technique. Kinetic data were obtained at a pressure of 400 torr of helium over the temperature ranges 295-491 ($k_1$), 295-602 ($k_2$), 292-491 ($k_3$), and 292-603 K ($k_4$). Rate-coefficient results are fitted to the modified-Arrhenius expressions $k_1$ (T) = 6.04 x $10^{-16}$T/sup 1.52/ exp(+220 cal $mol^{-1}$/RT) $cm^3$ $molecule^{-1}$ $s^{-1}$, $k_2(T) = 4.50 \times 10^{-15}$T/sup 1.21/ exp (-511 cal $mol^{-1}$/RT) $cm^3$ $molecule^{-1}$ $s^{-1}$, $k_3(T) = 1.09 \times 10^{-15}$T/sup 1.47/

exp(+249 cal mol$^{-1}$/RT) cm$^3$ molecule$^{-1}$ s$^{-1}$, and $k_3(T) = 3.48 \times 10^{-16}$T/sup 1.62/ exp(-112 cal mol$^{-1}$/RT) cm$^3$ molecule$^{-1}$ s$^{-1}$. Rate coefficients for abstraction of hydrogen atoms from methylene sites are determined and compared with their previous measurements on other alkanes. The kinetic isotope effect for abstraction of H and D atoms from cyclopentane and cyclohexane is characterized, and it is found to be very similar to that measured for H- and D-atom transfer to OH from the secondary sites in propane and n-butane.

20768 **Nucleophilic activation of carbon monoxide. 4. Dihydrogen reduction of the methoxycarbonyl adduct $Ru_3(CO)_{11}(CO_2CH_3)^-$.** Taube, D.J.; Rokicki, A.; Anstock, M.; Ford, P.C. (Univ. of California, Santa Barbara). *Inorganic Chemistry;* **26**: No. 4, 526-530(25 Feb 1987).

The anionic triruthenium cluster $Ru_3(CO)_{11}(CO_2CH_3)^-$ reacts with dihydrogen in dry THF to give methyl formate plus the hydride cluster $HRu_3(CO)_{11}^-$. Use of $D_2$ instead leads to the formation of $DCO_2CH_3$ plus $DRu_3(CO)_{11}^-$ as shown by $^2H$ NMR. The rate of the hydrogenation is demonstrated to be first order in [$H_2$] but inhibited by CO. These observations are interpreted in terms of a mechanism by which the principal pathway for reduction of the cluster involves the reversible dissociation of coordinated CO followed by rate-limiting $H_2$ addition to the unsaturated intermediate. Details of the synthesis and spectroscopic properties of the $Ru_3(CO)_{11}(CO_2CH_3)^-$ anion are also described. 24 references, 3 figures.

20769 **Structure and redox and photophysical properties of a series of ruthenium heterocycles based on the ligand 2,3-bis(2-pyridyl)quinoxaline.** Rillema, D.P.; Taghdiri, D.G.; Jones, D.S.; Keller, C.D.; Worl, L.A.; Meyer, T.J.; Levy, H.A. (Univ. of North Carolina, Charlotte). *Inorganic Chemistry;* **26**: No. 4, 578-585(25 Feb 1987). Contract AC05-84OR21400.

The synthesis, structure, and redox and photophysical properties of [Ru(bpy)/sub n/(BL)/sub 3-n/]$^{2+}$, where n = 0-2, bpy is 2,2′-bipyridine, and BL is 2,3-bis(2-pyridyl)quinoxaline, are described. The $[Ru(bpy)_2(BL)](PF_6)_2$ complex crystallized in the monoclinic space group $P2_1/a$ and the cell parameters are repeated. All non-H atoms were refined anisotropically to an R value of 0.0672 for 5766 reflections with $I > \sigma(I)$. The ruthenium to nitrogen bond distances were Ru-N(pyridine) = 2.06 A (average) and Ru-N(pyrazine) = 2.096 (4) A. Absorption spectra contained bands (250-300 nm) in the ultraviolet region that were assignable to ligand $\pi \rightarrow \pi^*$ transitions and visible bands (517-300 nm) that were assignable to $d\pi \rightarrow \pi^*$ MLCT transitions. Reduction potentials for the Ru/sup 3+/2+/ couples varied from about 1.40 to 1.70 V vs SSCE. Three reductions were observed and assigned to the one-electron reduction of each bidentate ligand. Weak luminescence was observed, and corrected emission energy maxima were located at 766 +/- 4 nm. Excited-state reduction potentials were estimated from the difference between emission energy maxima and ground-state reduction potentials. Excited-state lifetimes at room temperature in 4:1 EtOH-MeOH ranged from 167 to < 70 ns. Temperature-dependent-lifetime (90-298 K) data gave evidence for $\Delta E'$ values of 1100 +/- 300 cm$^{-1}$. The temperature dependence was attributed to either the third MLCT state according to the localized-orbital model or the presence of a fourth CT state for $[Ru(BL)_2(bpy)]^{2+}$, since little photochemistry was found for it, and to the third and/or the fourth CT state and the dd state for both $[Ru(BL)_2(bpy)]^{2+}$ and $[Ru(BL)_3]^{2+}$. 54 references, 7 figures, 6 tables.

20770 **Reaction dynamics for $O(^3P)+H_2$, $D_2$, and HD. VI. Comparison of TST and reduced dimensionality quantum and quasiclassical isotope effects with experiment.** Wagner, A.F.; Bowman, J.M. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Journal of Chemical Physics;* **86**: No. 4, 1976-1981(15 Feb 1987). Contract W-31-109-ENG-38;AC02-81ER10900.

Reduced dimensionality exact quantum and quasiclassical trajectory isotope effects are presented for the $O(^3P)+H_2$, $D_2$, and HD reactions. Two potential energy surfaces are used: the ab initio MODPOLCI and the semiempirical LEPS surfaces studied in previous papers in this series. Isotope effects are also calculated by conventional transition state theory with a Wigner tunneling correction. All the calculated results are compared to recent experimental measurements of the isotope effects. The measured values show that H atom abstraction is essentially the same from HH or HD, as is the D atom abstraction from either DD or DH. Only the reduced dimensionality quantum calculations on the MODPOLCI surface are in agreement with these results.

20771 **Variation of the electron attachment to n-$C_4F_{10}$ with temperature.** Datskos, P.G.; Christophorou, L.G. (Atomic, Molecular, and High Voltage Physics Group, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Chemical Physics;* **86**: No. 4, 1982-1990(15 Feb 1987). Contract AC05-84OR21400.

The total electron attachment rate constant k/sub a/(<ϵ>) for n-$C_4F_{10}$ has been measured using an electron swarm technique in the mean electron energy, <ϵ>, range 0.76 to 4.81 eV and over the temperature, T, range 300 to 750 K. The measured k/sub a/(<ϵ>,T) and the total electron attachment cross section σ/sub a/(ϵ,T) determined from these by unfolding are reported. The k/sub a/(<ϵ>) first decrease slowly with T between 300 and 400 K, then decrease precipitously between 400 and —500 K, and subsequently increase for T>500 K. The overall variation of k/sub a/ with T depends on <ϵ>. From the measured dependence of k/sub a/(<ϵ>) on the total gas number density and T we determined the contribution of dissociative and nondissociative attachment to k/sub a/ as a function of <ϵ>; the contribution of nondissociative attachment decreases with T and the contribution of dissociative attachment increases with T.

20772 **Nonadditivity of ab initio pair potentials for molecular dynamics of multivalent transition metal ions in water.** Curtiss, L.A.; Halley, J.W.; Hautman, J.; Rahman, A. (Chemical Technology Division/Materials Science and Technology Program, Argonne National Laboratory, Argonne, Illinois 60439). *Journal of Chemical Physics;* **86**: No. 4, 2319-2327(15 Feb 1987). Contract W-31-109-ENG-38;FG02-84ER45173.

Ab initio molecular orbital pair potentials for the interaction of $Fe^{2+}$ and $Fe^{3+}$ ions with $H_2O$ are reported. Molecular dynamics calculations of the static structure of the solvation shell of $Fe^{2+}$ and $Fe^{3+}$ in water using the ab initio pair potentials gives physically incorrect results, i.e., the coordination numbers are eight instead of six as observed experimentally. This problem has also been encountered by other workers for divalent transition metal ions in water. By computing three-body energies from the interaction of two water molecules with the cations, we show that the origin of the problem is most likely in the assumption of the additivity of the pair potentials, i.e., neglect of many-body forces. Empirical potentials are reported which take approximate account of the three-body forces and give coordination numbers of six for both $Fe^{2+}$ and $Fe^{3+}$ in water.

20773 **Crystal structure of coesite, a high-pressure form of $SiO_2$, at 15 and 298 K from single-crystal neutron and x-ray diffraction data: test of bonding models.** Smyth, J.R.; Smith, J.V.; Artioli, G.; Kvick, A. (Univ. of Colorado, Boulder). *Journal of Physical Chemistry;* **91**: No. 4, 988-992(12 Feb 1987). Contract AC02-76CH00016.

The crystal structure of a natural coesite from an eclogite rock fragment in the Roberts Victor kimberlite, South Africa, was determined at 15 K by neutron diffraction (a = 7.1357 (13) A, b = 12.3835 (26) A, c = 7.1859 (11) A, $\beta$ = 120.375 (16)°, C2/c), and at ~298 K by X-ray diffraction. Cell dimensions measured by neutron diffraction at 292 K (7.1464 (9), 12.3796 (19), and 7.1829 (8) A, 120.283 (9)°) differed from those determined by X-ray diffraction, probably because of a systematic absorption error for the latter. The strongly anisotropic nature of the thermal expansion is explained qualitatively by the relatively large changes (~1%) in the distances between the nonbonded oxygen neighbors and the relatively small changes of Si-O-Si and O-Si-O angles in the compact three-dimensional framework. There is a good, but not perfect, negative correlation between the eight independent Si-O distances and the five independent values for sec theta(Si-O-Si) at 15 K. It is weaker than that for 298 K, and the scatter from a straight-line prediction from molecular-orbital models for small clusters (e.g.,

$H_6Si_2O_7$) implies that it is desirably to consider additional forces, including repulsive forces between nonbonded oxygen neighbors. The combined at a for Si-O and Si-O-Si in coesite, quartz, and cristobalite at 10-15 K show less scatter than those for ~298 K, in accordance with the greater thermal response of framework geometry in the more open structures.

20774 **Chromium(III) hydrolysis constants and solubility of chromium(III) hydroxide.** Rai, D.; Sass, B.M.; Moore, D.A. (Pacific Northwest Labs., Richland, WA). *Inorganic Chemistry;* **26**: No. 3, 345-349(11 Feb 1987).

The solubility of freshly precipitated $Cr(OH)_3$ was determined in 0.01 M perchlorate solutions over a pH range of 3.8-14 and under a nitrogen atmosphere. Chromium concentrations in 0.0018-μm filtrates at times between 6 and 134 days, when the solubility was approached from both the undersaturation and oversaturation directions, showed that equilibrium is attained in < 6 days below pH 12 and in ~ 63 days above pH 12. X-ray diffraction analyses of the solids showed that freshly precipitated $Cr(OH)_3$ was amorphous and remained amorphous throughout the equilibration period. Chromium hydroxide exhibits amphoteric behavior, with a minimum solubility between pH 7 and 10. On the basis of the solubility of $Cr(OH)_3(s)$ as a function of pH, $CrOH^{2+}$, $Cr(OH)_3^0$, and $Cr(OH)_4^-$ were determined to be the dominant aqueous species in different pH regions. Thermodynamic equilibrium constants for the reaction are presented. No evidence for $Cr^{3+}$, $Cr(OH)_2^+$, or any polynuclear complexes was observed, even in solutions heated to 60 and 90°C, where polynuclear species are expected to form more rapidly. Although it is not possible to determine from these experiments the absolute value of the hydrolysis constants for reactions involving $Cr(OH)_2^+$ and Cr(III) polymeric species, the results do not set upper limits for the hydrolysis constants. 19 references, 4 figures, 3 tables.

20775 **Structure of $[(eta\text{-}C_5H_5)Fe(CO)_2(CS)]PF_6$, a comparison of M-CS and M-CO bonding.** Richardson, J.W. Jr.; Angelici, R.J.; Jacobson, R.A. (Iowa State Univ., Ames). *Inorganic Chemistry;* **26**: No. 3, 452-454(11 Feb 1987). Contract W-7405-ENG-82.

The complex $[(eta\text{-}C_5H_5)Fe(CO)_2(CS)]PF_6$ was prepared, crystallized, and its structure determined by x-ray crystallographic analysis. The atomic coordinates, isotropic thermal parameters and selected bond distances and angles are tabulated. The structure of the complex was shown to be composed of discrete cationic ($(C_5H_5Fe(CO)_2(CS)^+$) and anionic ($PF_6^-$) species, and the coordination of the iron was found to be octahedral. 23 references, 1 figure, 4 tables.

20776 **Photoionization mass spectrometric studies of SiH/sub n/ (n = 1—4).** Berkowitz, J.; Greene, J.P.; Cho, H.; Rus-hacekcic-acute-accent, B. (Physics Division, Argonne National Laboratory, Argonne, Illinois). *Journal of Chemical Physics;* **86**: No. 3, 1235-1248(1 Feb 1987). Contract W-31-109-ENG-38.

A photoionization mass spectrometric study of $SiH_4$ at T = 150 K reveals the presence of $SiH^+{}_4$ with an adiabatic threshold at 11.00 +- 0.02 eV. The implications for the structure of this Jahn—Teller split state are discussed. The appearance potentials of $SiH^+{}_3$ and $SiH^+{}_2$ are 11.54 +- 0.01 eV and ≦12.086 eV, respectively. The reaction of F atoms with $SiH_4$ generates $SiH_3$ ($X\ ^2A_1$), $SiH_2$ ($X\ ^1A_1$ and a $^3B_1$), and SiH ($X\ ^2Pi$) in sufficient abundance for photoionization studies. The measured adiabatic ionization potentials (eV) are: $SiH_3$, 8.01 +- 0.02; $SiH_2$ ($X\ ^1A_1$), 9.15 +- 0.02 or 9.02 +- 0.02; $SiH_2$ (a $^3B_1$), 8.24$_4$ +- 0.02$_8$; SiH, 7.91 +- 0.01. The singlet—triplet splitting in $SiH_2$ is either 0.78 +- 0.03 or 0.91 +- 0.03 eV. The dissociation energy of SiH is 2.98 +- 0.03 eV. A Rydberg series is observed, converging to $SiH^+$ (a $^3Pi$) at 10.21 +- 0.01 eV. Heats of formation of the various neutral and ionic species are presented, as are the stepwise bond energies of $SiH_4$.

20777 **Tetramethylammonium perchlorate: Ion size parameters in solution and in the solid state.** Ho, P.C.; Ramsey, J.B. (Chemistry Div., Oak Ridge National Lab., Oak Ridge, TN). *Journal of Chemical and Engineering Data;* **31**: No. 4, 430-434(Oct 1986).

The association constants at 25°C of tetramethylammonium perchlorate in pyridine, 2-butanone, acetone, benzontrile, and nitrobenzene have been determined. It is shown that the association constants (K/sub A/) conform to a straight-line relation between ln K/sub A/ and 1/D as predicted by the Dennison-Ramsey theory of ion-pair formation. The α parameter, the distance between ions in the ion pair, of this salt determined from the slope of this straight line (α = e/sup 2//kT x slope) is found to be 7.3 +- 0.1 A, considerably larger than the N-Cl distance in its crystal.

20778 **Isopiestic measurements of the osmotic and activity coefficients for the system HClO/sub 4/-Ba(ClO/sub 4/)/sub 2/-H/sub 2/O at 25°C.** Rush, R.M. (Oak Ridge National Lab., Oak Ridge, TN). *Journal of Chemical and Engineering Data;* **31**: No. 4, 478-481(Oct 1986).

Isopiestic measurements of the osmotic coefficients are presented for the system HClO/sub 4/-Ba(ClO/sub 4/)/sub 2/-H/sub 2/O. Parameters obtained from these results are used to calculate values of the osmotic coefficient and the activity coefficient of each component.

20779 **Comparison of perfluoro- and perhydro-polynuclear-aromatic hydrocarbon cation salts.** Richardson, T.J.; Tanzella, F.; Bartlett, N. (Dept. of Chemistry, Univ. of California, Berkeley, CA 94720). *American Chemical Society, Division of Petroleum Chemistry, General Papers, Preprints;* **31**: No. 3, 817(Sep 1986). (CONF-860911—).

From 192. American Chemical Society national meeting; Anaheim, CA, USA (7 Sep 1986).

Electron-oxidation of the perfluoroaromatics, C/sub 6/F/sub 6/ and C/sub 10/F/sub 8/ by O/sub 2/+ salts yields salts of the radical cations C/sub 6/F/sub 6//sup +/ and C/sub 10/F/sub 8//sup +/ which are Curie-Law paramagnets. The perfluoro analogues of the 'metallic' (C/sub 10/H/sub 8/)2/sup +/ salt do not exist. The π electrons of the fluorine ligands of the perfluoro aromatics are responsible for the failure of these species to make metallic stacks. Attempts to prepare C/sub 6/H/sub 6//sup +/ salts have given the para phenylene cation salts (C/sub 6/H/sub 4/)/sub n//sup +/MF/sub 6//sup -/ which are good electronic conductors. Electron oxidation of perhydropoly-nuclear aromatics by C/sub 6/F/sub 6//sup +/ salts or by AsF/sub 5/ e.g. 3AsF/sub 5/ + 2C/sub 24/H/sub 12/ → 2C/sub 24/H/sub 12//sup +/AsF/sub 6//sup -/ + AsF/sub 3/, yields what appear to be salts of the polynuclear aromatic cations. The magnetic and electrical properties of such salts are described.

20780 **The dissolving metal reduction of polynuclear aromatic compounds.** Rabideau, P.W. (Purdue School of Science at Indianapolis, Indiana Univ., Purdue Univ. at Indianapolis, Indianapolis, IN). *American Chemical Society, Division of Petroleum Chemistry, General Papers, Preprints;* **31**: No. 3, 791-797(Sep 1986). (CONF-860911—).

From 192. American Chemical Society national meeting; Anaheim, CA, USA (7 Sep 1986).

The reaction of benzene and its derivatives with alkali metals in liquid ammonia with alcohol cosolvent, is known as the "Birch Reduction". As expected with anionic intermediates, 1-substituted-1, 4-dihydro products result from electron withdrawing groups, and 2, 5-dihydro products with electron donors. Application of these conditions to polynuclear aromatic compounds (PA's) (1c) resulted in complications, since the initially formed products were themselves subject to reduction under the reaction conditions. Although methods such as the use of iron salts were devised to minimize such complications, more recently developed procedures avoid the use of alcohol altogether, and employ stronger quenching agents like water or ammonium chloride added after reaction with the alkali metal is complete. In the absence of alcohols, it was also found that the PA/alkali metal solutions could be reacted with alkyl halides to produce dialkylated products (e.g., anthracene) (1c).

20781 **Metal-mediated making and breaking of carbon-carbon bonds in aromatic hydrocarbons.** Eisch, J.J. (Dept. of Chemistry, State Univ. of New York at Binghamton Binghamton, NY 13901). *American Chemical Society, Division of Petroleum Chemistry, General Papers, Preprints;* **31**: No. 3, 798-802(Sep 1986). (CONF-860911—).

From 192. American Chemical Society national meeting; Anaheim, CA, USA (7 Sep 1986).

Because of the thermodynamic stability of the aromatic sextet, the tendency of many unsaturated compounds, such as alkenes and alkynes, to form aromatic systems is readily comprehensible. Thus, the Reppe cyclotrimerization of alkynes to benzenes by agency of (Ph/sub 3/P)/sub 2/(CO)/sub 2/Ni is no cause for wonder. But the similar cyclotetramerization of certain alkynes to the non-aromatic cyclooctatetraenes by nickel(0) or nickel (II) cyanide must, in contrast, be astonishing. Yet a closer study of the behavior of both nickel(0) complexes and of alkali metals reveals that both metals are able to disrupt aromatic systems almost as readily as they can induce their formation. Basic both to the formation and the disruption of aromatics by low-valent metal reagents $M^0$ appears to be the possibility of electron transfer from the metal to a sufficiently low-lying antibonding molecular orbital of the reagent hydrocarbon. This paper analyzes the formation and chemical behavior of intermediates with examples drawn from reactions of lithium and of nickel. Emphasis is on the formation of new C-C sigma-bonds in aromatic systems with the preliminary disruption of C-C pi-bonds. Such processes will be shown to hold great promise for the rational construction of polycyclic aromatics.

**20782 SANS study of alkyl polyoxyethylene sulfate Micelles. Sodium dodecyl(oxyethylene)$_4$ sulfate in $D_2O$ at 25°C.** Triolo, R.; Casonetti, E. (Istitutio Chimica Fisica, Palermo). *Journal of Solution Chemistry;* **15**: No. 5, 377-386(May 1986).

n-$C_{12}H_{25}(OC_2H_4)_4SO_4Na$ micelles have been investigated by small angle neutron scattering technique. Results have been obtained for a series of solutions of variable concentration of surfactant and for an approximately 0.07M solution to which different amounts of NaCl were added. Micellar parameters, aggregation number, and apparent charge have been compared to those previously obtained for $C_{12}H_{25}(OC_2H_4)_8SO_4Na$. On changing the surfactant concentration, the growth gradient of micelles of the latter is similar to the growth gradient of micelles of $C_{12}H_{25}(OC_2H_4)_4SO_4Na$ when no excess salt is present. In the presence of added electrolyte, $C_{12}H_{25}(OC_2H_4)_2SO_4$ has a higher growth gradient than $C_{12}H_{25}(OC_2H_4)_4SO_4$. This result has been interpreted in terms of effect of the oxyethylene group. The monodisperse core + shell spherical model of micellar structure previously proposed for this class of surfactant seems to hold in a wide range of concentrations of surfactant and/or added electrolyte.

**20783 A process for conversion of methane to higher hydrocarbons.** Taylor, C.E.; Noceti, R.P. (U.S. Dept. of Energy, Pittsburgh Energy Technology Center, P.O. Box 10940, Pittsburgh, PA 15236). pp 480-485 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—).

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

Existing processes have been assembled in a novel combination capable of producing higher hydrocarbons from methane with high yield and selectivity. Methane, oxygen, and hydrogen chloride react over an oxyhydrochlorination (OHC) catalyst in the first stage to produce chloromethane and water. In the second state, the chloromethane is catalytically converted to higher hydrocarbons, namely, paraffins, cycloparaffins, olefins, and aromatics, by an alumino-silicate zeolite. In the process described, the final hydrocarbon mixture is largely in the gasoline (C/sub 4/-C/sub 10/) boiling range.

**20784 Technique for observing oxygen diffusion along grain boundary regions in synthetic forsterite.** Condit, R.H.; Weed, H.C.; Piwinskii, A.J. (Lawrence Livermore National Lab., CA). pp 97-105 of Point defects in minerals. Washington, DC; American Geophysical Union (1985). Contract W-7405-ENG-48.

A technique is described for observing oxygen diffusion into synthetic forsterite, $Mg_2SiO_4$. An oxygen-18 isotope tracer was used in a gas-solid interchange anneal. Tracer penetration into $Mg_2SiO_4$ was examined by the technique of proton bombardment activation to convert the oxygen-18 into radioactive fluorine-18, followed by autoradiography. This is the first application of this technique to silicate diffusion studies and is concerned with grain boundary regions which contain other phases than the matrix material. High diffusion rates measured at 1374 C are related to the presence of molten material, while at 1107 C there is evidence for penetration of oxygen gas along cracks in the grain boundary region. The authors best diffusion coefficient obtained at 1325 C is in general accord with earlier predictions for grain boundary diffusion, albeit higher. This suggests that the grain boundary material is enriched in dislocations and interphase contacts. This technique for observing oxygen-18 tracer should be applicable to studies of grain boundary and dislocation diffusion and to studies of solid-gas reactions. 16 references.

## 4004 Electrochemistry

*REFER ALSO TO CITATION(S) 20447, 20712, 20762*

**20785 (PNL-SA—13708) Electropolishing applications in the nuclear industry.** Allen, R.P. (Pacific Northwest Lab., Richland, WA (USA)). Jul 1986. Contract AC06-76RL01830. 18p. (CONF-861146—13). NTIS, PC A02/MF A01; GPO Dep. File Number DE87003307.

From AIChE winter annual meeting; Miami, FL, USA (2 Nov 1986).

Commercial electropolishing technology has been developed into a rapid, effective decontamination method that is used worldwide to decontaminate a variety of metallic components and structures. The pre-polishing of surfaces to minimize contamination pickup and facilitate subsequent decontamination is a rapidly emerging technology that can be applied to large components using in situ techniques. 8 refs.

**20786 New mechanistic probes of hydride abstraction from rhenium-alkyl complexes (eta$^5$-$C^5H^5$)Re(NO)($PPh_3$)(R) by $Ph_3C^+PF_6^-$; evidence for initial electron transfer.** Bodner, G.S.; Gladysz, J.A.; Nielsen, M.F.; Parker, V.D. (Univ. of Utah, Salt Lake City). *Journal of the American Chemical Society;* **109**: No. 6, 1757-1764(18 Mar 1987).

The mechanism of hydride abstraction from rhenium-alkyl complexes R-(Re) ((Re) = (eta$^5$-$C_5H_5$)Re(NO)($PPh_3$)) by $Ph_3C^+PF_6^-$ is probed by study of the equilibrium R-(Re) + $Ph_3C^+$ ⇌ R-(Re)/sup .+/ (eq v) and the effect of oxygen on the rate and deuterium kinetic isotope effect. Equilibrium constants $K_s$ are determined in $CH_2Cl_2$ at 208 K from reversible potential measurement for R = $PhCH_2$ (1, 2.5 x $10^{-5}$), $(CH_3)_2CHCH_3$ (2, 7.9 x $10^{-3}$), and $Ph(CH_3)CH$ (3, 5.0 x $10^{-2}$). When generated electrochemically in separate experiments, R-(Re)/sup .+/ and $Ph_3C$/sup ./ are stable under the reaction conditions. Upon mixing $CH_2Cl_2$ solutions of the reactants in (v), rapid reactions ensue giving $Ph_3CH$ and hydride abstraction products derived from R-(Re). Nearly diffusion controlled rate constants are found for the reaction between $Ph_3C$/sup ./ and $O_2$. Rate enhancements of ca. an order of magnitude are observed when reactions are carried out in the presence of oxygen, while the rhenium products are essentially unchanged. A deuterium kinetic isotope effect, k/sub H//k/sub D/ = 5.4, is found for reactions of $PhCH_3$-(Re) and $PhCD_3$-(Re) under nitrogen but not in the presence of oxygen. In the presence of $O_2$, as much as 70% of the organic product is benzophenone, arising from decomposition of $Ph_3COOH$.

**20787 Electroreflectance spectroscopy of emersed gold electrodes in the vacuum ultraviolet.** Berg, S.L. Ames, IA; Iowa State Univ. (1986). 153p. University Microfilms Order No. 86-27,092.Contract W-7405-ENG-82.

Thesis (Ph. D.).

Electroreflectance spectra of emersed polycrystalline gold films were measured in the vacuum ultraviolet spectral region from 3 to 11 eV. The measurements were performed using synchrotron radiation under high vacuum conditions. Large reflectance differences were observed for an emersion potential difference of 0.8 V. The electroreflectance spectra are thought to be due primarily to electrolyte effects, with smaller contributions from the gold. Surface state optical adsorption from the predominantly (111) surface was speculated to be one contribution. Although these measurements are insufficient to draw definite conclusions, they show that electroreflectance spectroscopy on emersed metal electrodes must

be considered as a possible future tool for the study of the metal electrolyte interface.

## 4005 Photochemistry

*REFER ALSO TO CITATION(S) 20712, 20752, 20760, 20761, 20769, 20787, 21156*

**20788 Conformation and electronic relaxation of molecular triplet excimers: triplet excimers of naphthalene and related molecules.** Lim, E.C.; Locke, R.J.; Lim, B.T.; Fujioka, T.; Iwamura, H. (Wayne State Univ., Detroit, MI). *Journal of Physical Chemistry;* **91**: No. 6, 1298-1300(12 Mar 1987).

Experimental evidence is presented that demonstrates the formation of L- (or butterfly-) shaped triplet excimers in naphthalene and related molecules. The radiative and nonradiative decay rates of the triplet excimers are at least two orders of magnitude greater than those of the corresponding triplet monomers, consistent with the prediction of an earlier study.

**20789 Thermal and photochemical reactions of sulfhydryl radicals. Implications for colloid photocorrosion.** Mills, G.; Schmidt, K.H.; Matheson, M.S.; Meisel, D. (Argonne National Lab., IL). *Journal of Physical Chemistry;* **91**: No. 6, 1590-1596(12 Mar 1987). Contract W-31-109-ENG-38.

Several thermal and photochemical reactions of sulfhydryl radicals, either in their monomeric (S/sup .-//HS/sup ./) or dimeric $H_2S_2$/sup .-/) form, have been studied by using the pulse radiolysis technique. The dimer form is shown to react with $O_2$ and methylviologen ($MV^{2+}$). The monomer reacts with $O_2$ to produce a transient addition product, $SO_2$/sup .-/, which further proceeds to give superoxide radicals. The dimer reacts slower with $O_2$ by electron transfer. The reaction of S/sup .-/SH/sup ./ with $MV^{2+}$ yields several addition products which strongly absorb at λ/sub max/ = 485 nm. These are partially converted to MV/sup .+/, either through a unimolecular process or by reaction with another $NV^{2+}$ molecule. Implications of these observations for the photocorrosion of semiconductor colloidal sulfides are discussed. In particular, the possibility of reduction processes by surface-adsorbed sulfhydryl radicals, produced by hole trapping at the colloid surface, is considered.

**20790 Time-resolved study of singlet molecular oxygen ($^1m$/sub g/$O_2$) formation in a solution-phase photosensitized reaction: a new experimental technique to examine the dynamics of quenching by oxygen.** Iu, K.; Ogilby, P.R. (Univ. of New Mexico, Albuquerque). *Journal of Physical Chemistry;* **91**: No. 6, 1611-1617(12 Mar 1987).

The solution-phase, time-resolved phosphorescence of singlet molecular oxygen ($^1\Delta$/sub g/$O_2$), created by energy transfer from a sensitizer, has been examined by using a near-infrared detection system capable of resolving events that result in the formation of $^1\Delta$/sub g/$O_2$. As a method by which to examine oxygen quenching reactions, this approach is seen to complement flash absorption studies. Unlike existing experimental techniques, however, their approach is uniquely sensitive to rate-limiting steps that might exist during the energy-transfer process to form $^1\Delta$/sub g/$O_2$. In this report, they present oxygen quenching rate constants for the triplet state of five different molecules in several solvents. In addition, they suggest that a static quenching component may be involved in the oxygen-induced deactivation of a triplet state.

**20791 Multiphoton ionization of fluoranthene in tetramethylsilane.** Faidas, H.; Christophorou, L.G. (Atomic, Molecular, and High Voltage Physics Group, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Chemical Physics;* **86**: No. 5, 2505-2509(1 Mar 1987).

The multiphoton ionization of fluoranthene in liquid tetramethylsilane in the laser excitation wavelength λ/sub l/ range 370—550 nm is reported. From measurements of the laser wavelength and power dependencies of the ionization signal the ionization threshold was determined to be —5.7 eV. Two ionization mechanisms were identified in this wavelength region: (1) direct two-photon ionization for λ/sub l/ approx. <435 nm and (2) three-photon ionization: involving two-photon excitation followed by relaxation to either the first and/or the second excited singlet state and subsequent one-photon ionization: which becomes the sole photoionization mechanism for λ/sub l/ approx. >435 nm. In the wavelength region 400≦λ/sub l/ ≦435 nm both mechanisms occur.

**20792 Photodissociation as a quantum transition: Photofragment vibrational distributions of $C_2N_2$ (C-italic-tilde $^1$Pi/sub u/) predissociation.** Dateo, C.E.; Kresin, V.Z.; Dupuis, M.; Lester W.A. Jr. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Journal of Chemical Physics;* **86**: No. 5, 2639-2652(1 Mar 1987). Contract AC03-76SF00098.

Polyatomic indirect photodissociation is treated as a quantum transition between quasidiscrete and dissociative (photofragment) states. Our adiabatic method is followed to describe the nuclear dynamics of the dissociative state. Ab initio MCHF excited electronic potential energy surfaces are constructed and used to determine heavy-particle dynamics. The theory is applied to single-photon predissociation of $C_2N_2$(C-italic-tilde $^1$Pi/sub u/) at 164, 158.7, and 153.6 nm to form CN($X\ ^2\Sigma^+$) + CN($A\ ^2$Pi). Theoretical predictions are found to be in good agreement with recent experimental product vibrational energy distributions.

**20793 Photodissociation of $CF_2BrCH_2I$ at 248, 266, and 308 nm.** Minton, T.K.; Nathanson, G.M.; Lee, Y.T. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory and Department of Chemistry, University of California, Berkeley, California 94720). *Journal of Chemical Physics;* **86**: No. 4, 1991-2006(15 Feb 1987).

The technique of photofragmentation translational spectroscopy has been usedto study the photodissociation of $CF_2BrCH_2I$ at excitation wavelengths of 248, 266, and 308 nm. The primary photofragments are $CF_2BrCH_2$ and either$I(^2P_1$/sub //$_2)$ or $I(^2P_3$/sub //$_2)$, although some C—Br bond fission does occur at 248 and 266 nm. A large fraction of the $CF_2BrCH_2$ radical product contains enough internal excitation after the primary process to undergo secondary dissociation into $CF_2CH_2$ and Br. Secondary dissociation is also observed to take place at 248 and 266 nm via absorption of a photon by the $CF_2BrCH_2$ photofragment. By observing the threshold for the spontaneous secondary dissociation process, the reaction enthalpy for $CF_2BrCH_2I \rightarrow CF_2CH_2 + Br + I$, was determined to be 67.5 +- 2 kcal/mol, which leads to: Δ H/sup circle-open//sub f//sub ,0/ ($CF_2BrCH_2I$) = -92.6 +- 2 kcal/mol. The c.m. translational energy distributions were derived for both the $I(^2P_1$/sub //$_2)$ and $I(^2P_3$/sub //$_2)$ dissociation channels resulting from primary C—I bond breakage. The $I(^2P_1$/sub //$_2)/I(^2P_3$/sub //$_2)$ branching ratios are 3.3, 9.0, and 0.5 for excitation wavelengths of 248, 266, and 308 nm, respectively. The translational energy distributions also reveal that a major fraction of the $CF_2BrCH_2$ product radicals are formed with high internal energies, averaging around 50% of the excess energy.

**20794 Classical trajectory study of laser-induced dissociation dynamics in triatomic molecules.** Liu, W.K.; Turfa, A.F.; Fletcher, W.H.; Noid, D.W. (Univ. of Waterloo, Ontario). *Journal of Physical Chemistry;* **91**: No. 4, 834-837(12 Feb 1987). Contract AC05-84OR21400.

The dissociation dynamics of the excited states of the nonbending model triatomic molecules $H_2O$ and $D_2O$ in the presence of a laser is studied classically. In particular, the authors are interested in quasi-bound, largely nondissociative, states whose energy levels lie above the dissociation limit of the molecule. It is found that coupling of a laser field to the molecule initially prepared in such states would enhance the dissociation probabilities and rates, although the energy absorbed by the molecule is very small.

**20795 Quantum size effects of in situ generated colloidal CdS particles in dioctadecyldimethylammonium chloride surfactant vesicles.** Watzke, H.J.; Fendler, J.H. (Syracuse Univ., NY). *Journal of Physical Chemistry;* **91**: No. 4, 854-861(12 Feb 1987).

CdS particles were in situ generated in the presence of dioctadecyldimethylammonium chloride (DODAC) surfactant vesicles. Four different methods of preparations were investigated. In preparation A, CdS particles were generated from $CdEDTA^{2-}$ distributed both at the inner and outer vesicle surfaces. CdS particles were localized only in the inner or at the outer surfaces of DODAC vesicles in preparations B and C, respectively. Preparation of D involved the generation of CdS from $Cd^{2+}$ ions electrostatically repulsed from the DODAC vesicle surfaces. Depending on the method of preparation and the stoichiometrical amounts of $H_2S$ added, CdS semiconductor absorption edges were found to range from 478 to 385 nm, corresponding to particle diameter variations between >50 and 22 A. Using surfactant vesicles as hosts for semiconductors has a number of advantages. They provide differential sites for CdS formation, shift the equilibrium between nucleation and particle growth toward the former, stabilize the growing particles along with the anions present ($Cl^-$, $OH^-$, $EDTA^{2-}$, and $SH^-$), and, most importantly, allow a convenient control of particle sizes and size distributions. The smallest sized CdS particles with the narrowest size distribution were obtained in preparation A. Smaller sized DODAC-vesicle-entrapped CdS particles were shown to undergo more efficient, photosensitized electron transfer to methylviologen than larger ones.

20796 **Photochemistry of trimethylgallium with applications to atomic gallium reaction kinetics.** Baughcum, S.L.; Oldenborg, R.C. (Chemistry Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 564-565(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

The photodissociation of gas-phase trimethylgallium at 193 nm has been investigated using the laser photolysis/laser induced fluorescence technique. Gallium atoms are produced by multiple-photon processes during the time of the excimer laser pulse and continue to be produced at long times after the photolysis pulse. The observed dependences on photolysis laser fluence, trimethylgallium pressure, and buffer gas pressure are consistent with a mechanism in which highly excited gallium methyl radicals undergo unimolecular decomposition to produce gallium atoms. Since this process can happen on time scales long compared to the photolysis laser pulse, these results may have important implications for studies of laser deposition of thin metal films.

## 4006 Radiation Chemistry

*REFER ALSO TO CITATION(S) 20597, 20662, 20762, 21226, 22027*

20797 **Fragmentation of acetone following excitation in the region of the oxygen K edge.** Nelson, M.C.; Murakami, J.; Anderson, S.L.; Hanson, D.M. (Department of Chemistry, State University of New York, Stony Brook, New York 11794-3400). *Journal of Chemical Physics;* **86**: No. 8, 4442-4445(15 Apr 1987).

The fragmentation of acetone following excitation in the region of the oxygen K edge was studied by time-of-flight mass spectroscopy. By comparing mass spectra obtained using various photon energies ranging from below to well above the threshold for oxygen 1s excitation, it is found that methyl ion production is strongly associated with excitation of an oxygen 1s electron. None of the excitations generated significant yields of atomic oxygen or carbon ions.

20798 **Transient phenomena in the pulse radiolysis of retinyl polyenes. 6. Radical ions of retinal homologues.** Bobrowski, K.; Das, P.K. (Univ. of Notre Dame, IN). *Journal of Physical Chemistry;* **91**: No. 5, 1210-1215(26 Feb 1987).

The spectral and kinetic behaviors of radical ions of several retinal homologues possessing varying chain lengths have been examined by pulse radiolysis in acetone, tetrahydrofuran, alcohols, and aqueous micelles. The absorption maxima of radical ions shift progressively to lower energies as the number of double bonds is increased. The rate constants for protonation of radical anions in alcohols, and with 1,1,1,3,3,3-hexafluoro-2-propanol added as a reagent in tetrahydrofuran, show decreasing trends upon increasing the polyene chain length. A similar chain length dependence is also noted in the reactivity of polyenal radical cations with water, triethylamine, and bromide ion. The absorption spectra of $C_{30}$ aldehyde (8'-apo-$\beta$-carotenal) radical anion in CTAB and Triton X-100 micelles suggest an alcohol-like nature of the environment probed by the long-chain polyenal. The radical anion decays via protonation by reaction with water, leading to the alcohol radical; the longer lifetime of the anion in CTAB than in Triton X-100 solution suggests that the cation pairing with the head groups in the former stabilizes the anion against its reactivity with water.

20799 **Pulse radiolysis study on electrons trapped in semiclathrates and non-clathrate hydrates.** Zagorski, Z.P. (Univ. of Notre Dame, IN). *Journal of Physical Chemistry;* **91**: No. 4, 972-978(12 Feb 1987).

Trapping of electrons in specific water molecule vacancies, observed previously in crystalline aqueous clathrates, has also been found in semiclathrates (e.g., tetramethylammonium hydroxide pentahydrate), in clathrates showing hydrogen bonds between host and guest molecules (e.g., piperazine clathrate), and also in inorganic hydrates (e.g., sodium carbonate decahydrate). The lifetime of the electron is sometimes longer than in the case of true clathrates; e.g., t/sub 1/2/ = 3.5 ms (first-order decay in piperazine clathrate). The existence of comparatively long-lived electrons at room temperature may be considered a general phenomenon. The condition for its occurrence is the presence of $OH^-$ or $F^-$ anion, which can substitute for $H_2O$ in the aqueous part of the compound and when displaced leaves an electron trap. In other ionic and nonionic compounds, the condition for the trapping of long-lived electrons is protonation of the principal compound, thereby leaving the solution or melt alkaline during the crystallization of the hydrate. Interpretation in terms of preexistent traps invokes the crystal imperfections chemistry, which in the case of hydrates has not yet been noticed. It has been assumed that electrons occupy the vacancies temporarily revealing their presence. In some clathrates and other hydrates, the long-lived electron traps do not occur; instead, the electron shows a similar spectrum (620 nm maximum), decaying by 2-3 orders of magnitude faster than in long-lived traps. It is assumed that this is a case of electron digging its own hole, although an alternative explanation may be through trapping in other kinds of crystal imperfections in the aqueous moiety of the hydrate.

20800 **Study of the natural $\alpha$-recoil damage in zircon by infrared spectra.** Wasilewski, P.J.; Senftle, F.E.; Vaz, J.E.; Thorpe, A.N.; Alexander, C.C. (Geological Survey, Washington, DC). *Radiation Effects;* **17**: 191-199(1973). Contract AS05-76ER04049.

Natural $\alpha$-recoil damage of 30 natural zircon specimens from Ceylon have been examined by studying the infrared absorption spectra from 1 to 15 $\mu$m. Two synthetic zircon specimens were also studied as undamaged reference specimens. The IR absorption coefficient at 6 $\mu$m (1666 $cm^{-1}$) was found to be a function of radiation damage. The IR data can be explained by a dual damage mechanism. The initial damage process produces degradation of the upsilon$_3$ vibrational mode in the IR spectra which can be explained by deformation of $SiO_4$ tetrahedra, whereas the predominant effect of the advanced stage of radiation damage is the breakdown of the zircon lattice into $SiO_2$ and $ZrO_2$ which causes a skewing of the upsilon$_3$ absorption band. These data substantiate the model of Pellas and clarify the dualistic nature of the radiation damage mechanism. 26 references, 8 figures, 3 tables.

## 4007 Radiochemistry And Nuclear Chemistry

*REFER ALSO TO CITATION(S) 20149, 20740, 20785, 21141, 21155, 21171, 21176, 21177, 21178, 21179, 21180, 21187*

20801 **(CSIR-RR—597) Standardization of /sup 57/Co by liquid scintillation coincidence counting.** (Council for Scientific and Industrial Research, Faure (South Africa). National Accelerator Centre). 1986. 21p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700852.

The theoretical and experimental aspects relating to the standardization of the nuclide /sup 57/Co are described. An ampoule containing a standardized /sup 57/Co solution was sent to

the Bureau International des Poids et Mesures for comparative measurement. The registration table and a plot based thereon are presented.

20802 **(IPEN-Pub—97) Quality control procedures for iodinated radiopharmaceuticals /sup 131/I-Hippuran and / sup 131/I-Risa.** (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). Feb 1986. 9p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700937.

A rapid miniaturized chromatography system was developed for fast determination of the proportion of inorganic radioactive iodide from radiopharmaceutical /sup 131/I-Hippuran and /sup 131/I-Risa. The technical parameters associated with miniaturized chromatography system were evaluated. One of the problems found in this system was the movement of the /sup 131/I-Risa from the origin with consequent overestimation of the inorganic iodide. A correct spot placement eliminated this problem.

20803 **(IPEN-Pub—102) Preparation of sup(99m)Tc - L - asparagine.** (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). May 1986. 10p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700940.

The interrelationship between technetium-99m, different reducing agents and the L-asparagine is studied. The maximum labelling yield, aboult 95%, is obtained by using the following molar ratios for ligand to reducing agents: L-asparagine: stannous ascorbate, 150:1; the L-asparagine: ascorbic acid, 50:1, and L-asparagine: stannous chloride, 800:1. This radiopharmaceutical is used for visualization of dependent asparagine tumours.

20804 **(KFK—4152) Organometallic chemistry of neptunium.** Bohlander, R. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Heisse Chemie; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Chemie). Sep 1986. 180p. (In German). NTIS (US Sales Only), PC A09/MF A01. File Number DE87751268.

Organometallic compounds of neptunium with carbocyclic ligands (C/sub 5/H/sub 5//sup -/=cp, C/sub 8/H/sub 8//sup 2-/=cot) have been prepared and investigated. Starting from tetrakis(cyclopentadienyle)neptunium(IV) (cp/sub 4/Np) and tris(cyclopentadienyle)neptunium(IV) chloride (cp/sub 3/NpCl) a lot of other Np(IV)-compounds can be obtained by ligand-exchange reactions. These have the general formula cp/sub 3/NpL with either inorganic ionic (L=Br/sup -/, I/sup -/, 1/2SO/sub 4//sup 2-/, NCS/sup -/, AlCl/sub 4//sup -/) or organic ligands (L=NC/sub 4/H/sub 4//sup -/, N/sub 2/C/sub 3/H/sub 3//sup -/, C=CH/sup -/, 1/2C=/sup 2-/, CH/sub 3//sup -/, C/sub 2/H/sub 5//sup -/, C/sub 6/H/sub 5//sup -/). Produced by reduction, tris(cyclopentadienyle)neptunium(III), cp/sub 3/Np) gives similar structured 1:1-adduct complexes, cp/sub 3/Np/sup */B, with Lewis-bases like THF, diethylether, acetonitrile. Physico-chemical properties and changes in the molecular structure of the complexes have been studied using IR-, FTIR- and optical spectroscopy (in the NIR, VIS and UV region) as well as by magnetic and EPR measurements and Moessbauer spectrometry. The results are discussed as to their classification within the actinide complex chemistry and to the comparison with lanthanide complexes.

20805 **(ORNL/TM—10284) The application of electroreduction of europium in the production of gadolinium-153.** Quinby, T.C.; Ramey, D.W.; Petek, M. (Oak Ridge National Lab., TN (USA)). Jan 1987. Contract AC05-84OR21400. 18p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87005281.

The Oak Ridge National Laboratory (ORNL) is presently producing $^{153}$Gd by the neutron irradiation of normal europium in the form of $Eu_2O_3$. The resulting europium-to-gadolinium weight ratio produced after a one-cycle (approximately 21 days) irradiation of normal europium in the High Flux Isotope Reactor (HFIR) approaches 17. To achieve the required ≧99.99% radiochemical purity of the $^{153}$Gd product and to achieve a respectable yield, the gadolinium must be quantitatively separated from the europium. This is achieved in a two-step process. First, the bulk (90 to 95%) of the europium is removed by the selective electroreduction of Eu(III) to Eu(II) using zinc electrodes in an electrolytic cell that contains $H_2SO_4$. Efficient europium removal is achieved in 4 h at a current density of 14.9 mA/cm$^2$. The remaining europium is separated from the gadolinium in a second step that involves the use of high-pressure ion exchange. The introduction of the electrolytic step in the $^{153}$Gd production process increased the process capacity by a factor of four and increased the $^{153}$Gd yield by ≧70%. 7 refs., 6 figs., 1 tab.

20806 **Moment analysis of the time-dependent transmission of a step-function input of a radioactive gas through an adsorber bed.** Lee, T.V.; Rothstein, D.; Madey, R. (Kent State Univ., OH). *Separation Science and Technology;* **21**: No. 6-7, 689-700(1986).

The time-dependent concentration of a radioactive gas at the outlet of an adsorber bed for a step change in the input concentration is analyzed by the method of moments. This moment analysis yields analytical expressions for calculating the kinetic parameters of a gas adsorbed on a porous solid in terms of observables from a time-dependent transmission curve. Transmission is the ratio of the adsorbate outlet concentration to that at the inlet. The three nonequilibrium parameters are the longitudinal diffusion coefficient, the solid-phase diffusion coefficient, and the interfacial mass-transfer coefficient. Three quantities that can be extracted in principle from an experimental transmission curve are the equilibrium transmission, the average residence (or propagation) time, and the first-moment relative to the propagation time. The propagation time for a radioactive gas is given by the time integral of one minus the transmission (expressed as a fraction of the steady-state transmission). The steady-state transmission, the propagation time, and the first-order moment are functions of the three kinetic parameters and the equilibrium adsorption capacity. The equilibrium adsorption capacity is extracted from an experimental transmission curve for a stable gaseous isotope. The three kinetic parameters can be obtained by solving the three analytical expressions simultaneously. No empirical correlations are required.

## 4008 Combustion, Pyrolysis, And High-temperature Chemistry

*REFER ALSO TO CITATION(S) 20894*

20807 **(ISL-CO—41/85) Measurement of the velocity and temperature of ignition gas and the role of the particles in the ignition mechanism.** Mach, H. (Institut Franco-Allemand de Recherches de Saint-Louis, 68 (France)). Dec 1986. 51p. (In German). (ETN—87-98797; CONF-8512119—1). NTIS, PC A04/MF A01.

From Conference CCG-Lehrgang: An- und Abrandvorgaenge von Treibladungspulvern; Weil am Rhein, F.R. Germany (2 Dec 1985).

Measuring techniques for the velocity and temperature of the ignition gases for propellant charge powders are discussed. The ignition clouds consist of a gaseous component and a component in the form of particles. For the measurement of the cloud velocity, the propagation of the flame front, the streak method, the two-focus method, laser Doppler anemometry, the correlation method, and the laser Doppler velocimeter method are discussed. For the measurement of the cloud temperature, thermoelectric and spectroscopic methods are discussed. It is shown that these measuring methods are primarily based on the particles present in the flow. Origin and detection of the particles, their size distribution and their concentration, and the particle ignition are treated. The mass and energy flow in ignition clouds is discussed.

20808 **(NP—7770067) Two-component speed measuring in methane-diffusion flames.** Bahnen, R. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Maschinenwesen). 20 Nov 1984. 78p. (In German). NTIS (US Sales Only), PC A05/MF A01. File Number DE87770067.

The aim of this study was to describe the velocity fields of a rotationally symmetric turbulent methane diffusion flame, for which purpose one used a double-beam laser-doppler anemometer. This method means that the Doppler-shifted scattered light emitted by particles contained in the fluid is superimposed by two beams at the

photoreceiver, where a beat frequency (Doppler frequency) is created which does not depend on the angle of emergence. This modulation frequency of the scattered light is directly proportional to the component of the particle velocity which lies in the plane spread by the two beams and is vertical to the optical axis. The two-component measuring method was also suitable for resolving Reynolds turbulent shear stress and the lower radial velocities measuring results of velocity profiles are shown in various diagrams. Schlieren photographs of large regular structures substantiate the results. (HWJ).

# 42 ENGINEERING

*REFER ALSO TO CITATION(S) 20587*

20809 **(K/TS—11811) Liquid-core fiber optics: Transmission and nonlinear effects.** Allison, S.W.; Cates, M.R.; Gillies, G.T. (Oak Ridge Gaseous Diffusion Plant, TN (USA); Virginia Univ., Charlottesville (USA). Dept. of Physics). Dec 1986. Contract AC05-84OT21400. 18p. (CONF-8611137—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005960.

From International congress on applications of lasers and electro optics; Washington, DC, USA (1 Nov 1986).

Previous research on liquid-core fiber optics is surveyed. These waveguides exhibit a number of interesting characteristics which are of use to sensing, spectroscopy, and communications. Liquid-core optical fibers are discussed in regard to applications involving high-peak-power transmission of laser light. The roles of liquid properties, nonlinearities, and fiber-to-waveguide coupling are discussed. The self-healing capability of such a waveguide following laser-induced breakdown is demonstrated. 19 refs., 4 figs.

20810 **(SAND—86-1935C) Experimental determination of the mass matrix using a constrained least squares solution.** Smallwood, D.O.; Gregory, D.L. (Sandia National Labs., Albuquerque, NM (USA)). 30 Jan 1987. Contract AC04-76DP00789. 28p. (CONF-870479—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005537.

From AIAA/ASME structural dynamics and materials conference; Monterey, CA, USA (6 Apr 1987).

The method uses a sum of weighted acceleration signals to experimentally predict the external force which excites a mechanical system. The predicted force is compared with the measured force and a constrained least squares solution is found for the optimum set of weights for the acceleration measurements. The weights calculated are equivalent to the effective mass of the system at the measurement locations. The method is sensitive to the bandwidth of the excitation and the spatial distribution of the measurement locations. For this reason the weights are calculated as a function of bandwidth and an error measure is calculated at each bandwidth to help evaluate the optimum bandwidth for a particular set of measurements. The use of constraints is strongly recommended to achieve a set of physically realizable weights. Several examples are given to demonstrate the technique. The primary use of the technique to date has been to estimate the dynamic forces acting on non-rigid bodies.

## 4202 Facilities And Equipment

*REFER ALSO TO CITATION(S) 19975, 19985, 20049, 20055, 20057, 20382, 20419, 21036, 21456*

20811 **(AD-A—175201/3/XAB) Test and evaluation of constant-flow devices for use in SSN AFFF proportioning systems. Interim report, January-May 1986.** Williams, F.W.; Back, G.G.; Burns, R.E.; Quellette, R.J.; Scheffey, J.L. (Naval Research Lab., Washington, DC (USA)). 4 Nov 1986. 33p. (NRL-MR—5873). NTIS, PC A03/MF A01.

Constant flow devices, which deliver a constant flow of liquid over a range of upstream and downstream pressures, have been suggested as an alternative to orifice plates for proportioning AFFF in SSN 21 fire-suppression systems. Operational and performance characteristics of two lightweight, inexpensive, commercially available constant-flow devices have significant advantages over orifice plates. Both models tested, however, showed performance degradation when subjected to simulated service conditions. A constant flow device with improved resistance to wear and to AFFF exposure is desirable. Since the constant-flow control devices tested improves proportioning efficiency but do not have optimum characteristics, investigation of improved devices or methods is recommended.

20812 **(AD-A—175629/5/XAB) Phenomenological manifestations of large-curvature tunneling in hydride-transfer reactions.** Kreevoy, M.M.; Ostovic, D.; Truhlar, D.G.; Garrett, B.C. (Chemical Dynamics Corp., Upper Marlboro, MD (USA)). 1986. 11p. NTIS, PC A02/MF A01.

Published in J. of Physical Chemistry, Vol. 90, No. 16, 3766-3774(1986).

An important consequence of recent dynamical theories of tunneling is that, because of large curvature of the reaction path in a typical H(+), or H(-) transfer, light-isotope transfer occurs in more extended nuclear frameworks than heavy-isotope transfer. This is now incorporated into the Marcus phenomenological theory relating reaction rate constants to equilibrium constants. It leads to Bronsted slope parameters that depend on the isotope transferred. The new theoretical formulation is tested on experimental data for hydride and deuteride transfer between nicotinamide adenine dinucleotide analogs and on computational data for hydrogen-atom and deuterium atom transfer between pseudo-atoms. The experimental kinetic isotope effects (KIE's) are shown to vary with reaction equilibrium constant (K/sub ij/) in a way that is quantitatively consistent with the theory. The critical configurations generated by the calculations vary from the saddle point and from each other in the way anticipated by the theory. However, the calculated KIE values are a rather scattered function of K/sub ij/, because the tunneling corrections are large and somewhat system specific. Overall, we believe that this combination of experimental and calculated results provides considerable support for the idea that large-curvature results provides considerable support for the idea that large-curvature tunneling needs to be considered in hydrogen transfer reactions.

20813 **(BDX—613-3628) Automatic MW attenuation calibration system linearity certification techniques.** Cable, J.W. (Allied Corp., Kansas City, MO (USA). Bendix Kansas City Div.). Jan 1987. Contract AC04-76DP00613. 11p. (CONF-861260—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005051.

From ARFTG conference digest conference; St. Petersburg, FL, USA (4 Dec 1986).

A method of calibration for sophisticated test equipment has been developed. This technique has been adapted for use with automatic attenuation measurement systems. After the equipment has been set up, the procedure operates without intervention.

20814 **(CONF-860939—3) ANL computer controlled target storage system: Status report.** Klimczak, G.W.; Nardi, B.G.; Travis, D.J. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87004681.

From 13. world conference of the Nuclear Target Development Society; Chalk River, Canada (17 Sep 1986).

Design and operation of an isotopic target storage system is described. Due to the cost and effort associated with nuclear target production, it is necessary to protect them. The storage system described was designed to protect up to 90 hydroscopic and readily oxidizing targets under vacuum of $10^{-6}$ torr. The computer controller maintains system integrity during normal use and emergency situations. (JDH)

20815 **(CONF-870134—2) On autonomous terrain model acquisition by a mobile robot.** Rao, N.S.V.; Iyengar, S.S.; Weisbin, C.R. (Louisiana State Univ., Baton Rouge (USA). Dept. of Computer Science; Oak Ridge National Lab., TN (USA)). 20 Jan 1987. Contract AC05-84OR21400. 7p. (CESAR—86/59). NTIS, PC A02. File Number DE87005719.

From Workshop on space telerobotics; Pasadena, CA, USA (20 Jan 1987).

The following problem is considered: A point robot is placed in a terrain populated by unknown number of polyhedral obstacles of varied sizes and locations in two/three dimensions. The robot is equipped with a sensor capable of detecting all the obstacle vertices and edges that are visible from the present location of the robot. The robot is required to autonomously navigate and build the complete terrain model using the sensor information. It is established that the necessary number of scanning operations needed for complete terrain model acquisition by any algorithm that is based on 'scan from vertices' strategy is given by $\Sigma$/sub i = 1/sup n/ N(O/sub i/) - n and $\Sigma$/sub i = 1/sup n/N(O/sub i/) - 2n in two and three dimensional terrains respectively, where O = {$O_1,O_2,...,$O/sub n/] set of the obstacles in the terrain, and N(O/sub i/) is the number of vertices of the obstacle O/sub i/.

**20816 (CONF-870301—3) Advanced manipulation for autonomous mobile robots.** Babcock, S.M.; Hamel, W.R.; Killough, S.M. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 9p. (CESAR—86/52). NTIS, PC A02/MF A01; GPO Dep. File Number DE87002818.

From International topical meeting on remote systems and robotics in hostile environments; Pasco, WA, USA (29 Mar 1987).

This paper describes the development, mechanical configuration, and control system architecture of a lightweight, high performance, seven-degree-of-freedom manipulator at the Center for Engineering Systems Advanced Research (CESAR). Current activities focusing on modeling and parameter identification will provide a well-characterized manipulator for analytical and experimental research in manipulator dynamics and controls, coordinated manipulation, and autonomous mobile robotics.

**20817 (CONF-870301—14) Intelligent operating systems for autonomous robots: Real-time capabilities on a hypercube super-computer.** Einstein, J.R.; Barhen, J.; Jefferson, D. (Oak Ridge National Lab., TN (USA); California Univ., Los Angeles (USA). Dept. of Computer Science). 1986. Contract AC05-84OR21400. 7p. NTIS, PC A02. File Number DE87004076.

From International topical meeting on remote systems and robotics in hostile environments; Pasco, WA, USA (29 Mar 1987).

Autonomous robots which must perform time-critical tasks in hostile environments require computers which can perform many asynchronous tasks at extremely high speeds. Certain hypercube multiprocessors have many of the required attributes, but their operating systems must be provided with special functions to improve the capability of the system to respond rapidly to unpredictable events. A "virtual-time" shell, under design for addition to the Vertex operating system of the NCUBE hypercube computer, and having such capabilities, is described.

**20818 (CONF-870354—3) On terrain acquisition by a finite-sized mobile robot in plane.** Rao, N.S.V.; Iyengar, S.S.; Jorgensen, C.C.; Weisbin, C.R. (Louisiana State Univ., Baton Rouge (USA). Dept. of Computer Science; Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 7p. (CESAR—86/60). NTIS, PC A02. File Number DE87005718.

From IEEE international conference on robotics and automation; Raleigh, NC, USA (30 Mar 1987).

The terrain acquisition problem deals with the acquisition of the complete obstacle terrain model by a mobile robot placed in an unexplored terrain. This is a precursory problem to many well-known find-path and related problems which assume the availability of the complete terrain model. In this paper, we present a method for terrain acquisition by a finite sized robot operating in plane populated by an unknown (but, finite) number of polygonal obstacles; each obstacle is arbitrarily located and has unknown (but, finite) number of vertices. The robot progressively explores newer vertices of the obstacles using sensor equipment. We show that the complete terrain model will be built by the robot in a finite time. We also show that at any point of time the partially acquired terrain suffices for the navigation of the robot during the exploration. Hence we conclude that the navigation techniques for known terrains can be applied for the robot navigation during exploration.

**20819 (CONF-8609173—8) Virtual-time operating-system functions for robotics application on a hypercube.** Einstein, J.R.; Barhen, J.; Jefferson, D. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87003658.

From 2. conference on hypercube multiprocessors; Knoxville, TN, USA (29 Sep 1986).

Hypercube multiprocessors used in autonomous robots carrying out time-critical tasks in unpredictable environments require special operating-system functions to provide the capability of rapid response to unforeseen external events. A "virtual-time" shell having such capabilities is under design for the Vertex operating system of the NCUBE hypercube computer.

**20820 (CONF-8610206—1) Performance improvement in a research and development facility.** Forbes, R.J.; Hoke, P.B. (Oak Ridge National Lab., TN (USA)). Oct 1986. Contract AC05-84OR21400. 7p. Juran Institute, Inc., 88 Danbur Road, Wilton, CT 0687-4409. File Number TI87004074.

From Impro '86: conference on quality improvement; Chicago, IL, USA (9 Oct 1986).

This paper traces the development of the Performance Improvement Process at the Oak Ridge National Laboratory from a two-year pilot phase to the Laboratory's current program. The unique challenges associated with the introduction of an improvement program in a research and development community are also discussed.

**20821 (DP-MS—86-66) Deaerator inspection and analysis.** Vormelker, P.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Plant). 1987. Contract AC09-76SR00001. 8p. (CONF-870314—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002649.

From Corrosion '87; San Francisco, CA, USA (9 Mar 1987).

Inspection of 11 deaerator systems at the Savannah River Plant (SRP) was performed after at least 30 years of service. Each deaerator system consists of a heater vessel and a storage vessel. Of 22 total vessels, only 11 were found to contain cracks, and these were repaired. The cracks ranged up to one inch in length, were both transverse and parallel to the welds, and none were through-wall. Weld samples were removed for metallurgical investigation, which revealed a very localized corrosion mechanism with a tightly bound oxide within the cracks. The operation and water chemistry of these deaerators are reviewed because up to four of these units operate in the same powerhouse and experience the same operating conditions.

**20822 (DP-MS—86-184) Mobile robots in research and development programs at the Savannah River site.** Martin, T.P.; Byrd, J.S.; Fisher, J.J. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1987. Contract AC09-76SR00001. 11p. (CONF-870301—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003114.

From International topical meeting on remote systems and robotics in hostile environments; Pasco, WA, USA (29 Mar 1987).

Mobile robots for deployment in nuclear applications at the Savannah River Plant (SRP) have been developed. Teleoperated mobile vehicles have been successfully used for several onsite applications. Development work using two research vehicles is underway to demonstrate semi-autonomous intelligent expert robot system operation in process areas. A description of the mechanical equipment, control systems, and operating modes of these vehicles is presented, including the integration of onboard sensors. A control hierarchy that uses modest computational methods is being developed at SRL to allow vehicles to autonomously navigate and perform tasks in known environments, without the need for large computer systems. Knowledge-based expert systems are being evaluated to simplify operator control, to assist in navigation functions, and to analyze sensory information.

**20823 (ESA-SP—65, pp vp) Fluid dynamic problems in the HM60 (Vulcain) cryogenic turbopump.** Albano, G.; Pempie, P. Aug 1986. NTIS, PC A10/MF A01. (ETN—87-98893; CONF-8606280—).

From International symposium on fluid dynamics and space; Rhode-Saint-Genese, Belgium (25 Jun 1986).

The most important fluid dynamic problems to be solved in the development of the HM60 (Vulcain) engine turbopumps are described. The engine will be used to power the central core of Ariane 5. The greatest difficulties concern cavitating flows, high Reynolds number flows, and the supersonic turbines.

20824 **(EUR—9992) Experimental criticality program to optimize pool storage and transport casks of PWR type fuel assemblies taking into account their burnup. Phase 1: feasibility study.** Maubert, L.; Poullot, G. (Commission of the European Communities, Luxembourg). 1985. 51p. (In French). NTIS (US Sales Only), PC A04/MF A01. File Number DE87751012.

As nuclear electric power production seems in the next years to be oriented towards the utilization of fuel containing uranium more enriched (up to 4.5% in $^{235}U$), it will be a necessity to take into account fuel burnup if the conception of fuel storage in pool, transport casks and reprocessing plant heads (dissolver) is kept. So reference criticality experiments are wished to be planned to qualify calculation methods in the field of spent fuels. The aim of this report is a feasibility study which includes two main chapters: the choice of the fuel rod specifications, and the definition of the experimental program.

20825 **(EUR—9993) Benchmark experiments on a lead reflected system and calculations on the geometry of the experimental facility using most of the commonly available nuclear data libraries.** Guillemot, M.; Colomb, G.; Maubert, L.; Poullot, G.; Hague, P.; Brown, M.L. (Commission of the European Communities, Luxembourg). 1985. 74p. NTIS (US Sales Only), PC A04/MF A01. File Number DE87751015.

A series of criticality benchmark experiments with a small LWR-type core, reflected by 30 cm of lead, was defined jointly by SEC (Service d'Etude de Criticite), Fontenay-aux-Roses, and SRD (Safety and Reliability Directorate). These experiments are very representative of the reflecting effect of lead, since the contribution of the lead to the reactivity was assessed as about 30% in $\Delta$ K. The experiments were carried out by SRSC (Service de Recherche en Surete et Criticite), Valduc, in December 1983 in the sub-critical facility called APPARATUS B. In addition, they confirmed and measured the effect on reactivity of a water gap between the core and the lead reflector; with a water gap of less than 1 cm, the reactivity can be greater than that of the core directly reflected the lead or by over 20 cm of water. The experimental results were to a large extent made use of by SRD with the aid of the MONK Monte Carlo code and to some extent by SEC with the aid of the MORET Monte Carlo Code. All the results obtained are presented in the summary tables. These experiments allowed to compare the different libraries of cross sections available.

20826 **(EUR—10037) Cutting of steel components by intergranular fissuration.** Chavand, J.; Gauthier, A.; Lopez, J.J.; Tanis, G. (Commission of the European Communities, Luxembourg). 1985. 57p. (In French). NTIS (US Sales Only), PC A04/MF A01. File Number DE87751017.

The present study relates to a new technique for cutting steel components of nuclear installations which virtually does not produce any secondary waste. This technique relies on a controlled intergranular fissuration produced by the introduction in the steel component of a molten metal in addition to the application of mechanical constraints. Cuttingds have been carried out on various materials, including: - stainless steel sheet from a few mm to 50 mm thick; - mild steel plates from 20 mm to 60 mm thick. It would be possible to perform cutting on pieces of mild steel up to 100 mm thick. On the basis of experimental results, heating methods were selected and fissuration parameters for the materials and the various thicknesses were determined; in the case of thin stainless steel sheets (1-5 mm), cutting in various positions (flat position, cornice) was carried out by remote handling techniques. Moreover, a thermal measurement installations using an infra-red camera performed to find out the time variation of the thermal field created in the component. Associated with the three-dimensional computation code COCO developed by the CEA, this installation allows to predict the evolution of the mechanical constraints around the fissured zone, when the cutting parameters vary and therefore to control the cutting mechanism.

20827 **(EUR—10232-Vol.1) System of large transport containers for waste from dismantling light water and gas-cooled nuclear reactors. Volume 1.** Price, M.S.T.; Lafontaine, I. (Commission of the European Communities, Luxembourg). 1985. 141p. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751009.

THe purpose of this volume is to introduce the main types of nuclear reactor in the European Community (EC), select reference plants for further study, estimate the waste streams from the reference reactors, survey the transport regulations and assess existing containers.

20828 **(EUR—10232-Vol.2) System of large transport containers for waste from dismantling light water and gas-cooled nuclear reactors. Volume 2.** Price, M.S.T.; Lafontaine, I. (Commission of the European Communities, Luxembourg). 1985. 136p. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751010.

The purpose of this volume is to assess the means of transportation of decommissioning wastes, costs of transport, radiological detriment attributable to transport and develops conceptual designs of large transport containers. The document ends with Conclusions and Recommendations.

20829 **(EUR—10348) Stowing of radioactive materials package during road transport on vehicles of a total weight under 38 tons.** Gilles, P.; Chevalier, G.; Pouard, M.; Jolys, J.C.; Draulans, J.; Lafontaine, I. (Commission of the European Communities, Luxembourg). 1985. 111p. (In French). NTIS (US Sales Only), PC A06/MF A01. File Number DE87750990.

Results of testing allow the formulation of recommendations for stowing radioactive material packaging for severe accidental conditions during land transport. For frontal impact kinetic energy acquired by deceleration should be totally absorbed by the packaging, as this energy is proportional to its mass it will stay on the vehicle. For side impact, the packaging should yield because kinetic energy to absorb, if fasteners are not deformed before rupture, can be largely over the packaging mass and damage could be very severe.

20830 **(GKSS—86/E/47) Robot application in an inert gas atmosphere up to 50 bar.** Aust, E.; Bohm, K.-H.; Domann, H. (GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.); GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Anlagentechnik). 1986. 25p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751618.

The research activities of GKSS for underwater technics include the development of robotic systems for automatic controlled underwater working. Of particular emphasis are underwater welding, cutting and preserving. First investigations with a modified industrial robot, producing welding specimens in argon-atmosphere up to 50 bar indicate good results with respect to the robot function and weldability of specimens. Special problems are given by the performance of the grinding process and in handling the tool-changing-system, which require further development. With 8 figs., 1 tab.

20831 **(HEDL-SA—3449-FP) The difficulties of writing procurement specifications for robots in nuclear applications.** Moore, F.W.; Bowen, W.W. (Hanford Engineering Development Lab., Richland, WA (USA)). 30 Apr 1986. Contract AC06-76FF02170. 9p. (CONF-8609242—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87005485.

From Robots west conference; Long Beach, CA, USA (22 Sep 1986).

The commercial robots available today were developed to primarily support the automotive or electronics industries. The adaptation of these robots and the current robotic technology to

handle and manufacture nuclear materials has had its problems. The operational space and maintenance constraints have special consideration. The robotic systems of today tend to not have the payload capability for nuclear applications or, if the payload is sufficient, the system is very large and has several operating and maintenance accessibility requirements. The process of specifying, purchasing, and modifying a robotic system is an expensive and time-consuming process. The procurement specification is critical to obtaining competitive quotations on robots for nuclear applications resulting in the most economical robotic system.

20832 **(IFVE-OEF—85-11) Facility for investigations at super low temperatures.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700893.

Refrigerator of /sup 3/He dilution in /sup 4/He is installed on the insert providing light access to a dissolution stage, that permits to carry out investigations of its various units. The refrigerator characteristics with two continuous heat exchangers different in design, a block-diagram of the installation electronic equipment and its brief description are presented. Basic investigations performed at the installation and the plans for the near-term investigations are enumerated. 11 refs.; 6 figs.

20833 **(K/TS—11793) Pulsed-power-handling capability of optical fibers.** Allison, S.W.; Cates, M.R.; Gillies, G.T. (Oak Ridge Gaseous Diffusion Plant, TN (USA); Virginia Univ., Charlottesville (USA). Dept. of Physics). Nov 1986. Contract AC05-84OT21400. 14p. (CONF-860680—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE87003310.

From CPEM conference; Gaithersburg, MD, USA (23 Jun 1986).

Crucial issues are presented for quantifying the damage and power handling characteristics of optical fibers for laser beam delivery and sensing as well as communications applications. In addition to the intrinsic surface and bulk damage threshold of a given fiber material, there are other factors to consider in efforts to quantify the onset of damage and/or undesirable effects. Included are nongaussian and nonuniform light distribution in the fiber, the nature of the core/cladding interface, and nonlinear phenomena (e.g., self-focusing). These aspects are illustrated by experiments. Theoretical modeling is under way to help elucidate the role of these factors.

20834 **(KAERC—202/85) Optimal design for two layered shield thickness on neutron and gamma rays.** (State Committee for Atomic Energy, Pyongyang (D.P.R. of Korea). Research Center for Atomic Energy.). 1985. 6p. (In Korean). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701466.

The paper deals with two methods for determining the optimal thickness providing the minimum weight for the two-layered spherical shield on the mixed radiation (neutron and γ-photon) on condition that the radiation safety should be satisfied and the thickness should have the positive value. The first is the searching method of the tolerance penetrating dose rate contour line (active condition line) and the second is the repeating monolinear approximation programming in which the nonlinear active condition is approximated to the linear restriction condition. In the former a convex function is devised and the Goldensearch is applied to obtain the point range of the nonlinear active condition line. Also, in the latter the selection region of the starting point and a criterion for the finishing point are determined.

20835 **(KFK-PFT—125) Advanced handling-systems with enhanced performance flexibility. Research report about future applications.** (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekttraegerschaft Fertigungstechnik; Fraunhofer-Institut fuer Produktionstechnik und Automatisierung (IPA), Stuttgart (Germany, F.R.)). Apr 1986. 228p. (In German). NTIS (US Sales Only), PC A11/MF A01. File Number DE87751291.

This report describes the results of a project related to future applications and requirements for advanced handling systems. This report consists of six chapters. Following the description of the aims the tools for setting up the requirements for the handling systems including the experience during the data acquisition process is described. Furthermore some information is given about the current state of the art of robotics and manipulators. Of paramount importance are the descriptions of applications and related concepts in the following chapters leading to specific categories of advanced handling units. The paper closes with the description of the first concepts for realization. With 37 figs., 10 tabs., 11 refs.

20836 **(UCRL—95152) DYNA3D: A computer code for crashworthiness engineering.** Hallquist, J.O.; Benson, D.J. (Lawrence Livermore National Lab., CA (USA)). Sep 1986. Contract W-7405-ENG-48. 20p. (CONF-8611126—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003818.

From 15. international finite element congress; Baden-Baden, F.R. Germany (17 Nov 1986).

A finite element program with crashworthiness applications has been developed at LLNL. DYNA3D, an explicit, fully vectorized, finite deformation structural dynamics program, has four capabilities that are critical for the efficient and realistic modeling crash phenomena: (1) fully optimized nonlinear solid, shell, and beam elements for representing a structure; (2) a broad range of constitutive models for simulating material behavior; (3) sophisticated contact algorithms for impact interactions; (4) a rigid body capability to represent the bodies away from the impact region at a greatly reduced cost without sacrificing accuracy in the momentum calculations. Basic methodologies of the program are briefly presented along with several crashworthiness calculations. Efficiencies of the Hughes-Liu and Belytschko-Tsay shell formulations are considered.

20837 **Quick temperature cycling sample holder for ultra-high vacuum surface studies.** O'Grady, W.E.; Melo, A.V.; Hoffman, R.W.; Chottiner, G.S. (Brookhaven National Laboratories, Upton, New York 11973). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 5: No. 2, 281-283(Mar 1987). Contract AC02-76CH00016.

An ultra-high vacuum compatible sample holder has been designed with copper gasketed flanges that allows quick cycling between low and high temperatures (77 K-1300 K). (AIP)

20838 **Bearing system.** Kapich, D.D. (to Dept. of Energy, Washington, DC). US Patent 4,641,978. 10 Feb 1987. Filed date 23 Oct 1984. vp.

A bearing system is described for supporting a rotating shaft on a housing, the bearing system comprising: a pair of primary bearings and a pair of backup bearings, each backup bearing comprising an outer race supported on the housing, an inner race on the shaft, rolling elements disposed between the races, and a retainer ring for constraining the rolling elements; the primary bearing being operative to support the shaft during normal operation in a first predetermined position such that in each of the backup bearings the rolling elements contact only one of the races; the backup bearings being configured so that upon axial displacement of the shaft in a predetermined direction form the first predetermined position to a second predetermined position the rolling elements in each bearing contact both races and the shaft is supported by the backup bearings; and shaft displacement means for selectively applying axial force to the shaft to displaced the shaft from the first predetermined position to the second predetermined position while the shaft rotates relative to the housing, the shaft displacement means including a chamber defined by surfaces on the housing and the shaft and means for introducing high pressure fluid into the chamber.

20839 **Support mechanism for a mirrored surface or other arrangement.** Cutburth, R.W. (to Dept. of Energy, Washington, DC). US Patent 4,640,591. 3 Feb 1987. Filed date 8 Nov 1985. vp.

A mechanism is described for supporting first means including a planer surface for movement relative to a vertical plane defined by particular intersecting x and y axes which extend horizontally and vertically, respectively, the mechanism comprising: (a) second means including a plurality of segments of an annular sur-

face which forms part of a sphere whose center defines the intersection of the x and y axes. The annular surface defines a z axis extending through the intersection of the x and y axes perpendicular to the vertical plane; (b) third means connecting the planer surface including first means with the second means such that the planer surface is positionably within the vertical plane and is itself intersected by the z axis at a particular point thereon. The third means includes bearing means disposed between the first means and the segments of the annular surface of the second means for allowing the first means to move in any direction on the annular surface segments including certain specific directions which allow the planer surface to pivot back and forth to a limited extent about both the x and y axes relative to the vertical plane; and (c) fourth means interconnecting the first and second means and cooperating with the third means for limiting the movement of the first means to the certain specific directions.

20840 **Design parameters for differentially pumped rotating platforms.** Columbia, M.R.; Thiel, P.A. (Department of Chemistry and Ames Laboratory, Iowa State University, Ames, Iowa 50011). *Review of Scientific Instruments;* **58**: No. 2, 309-310(Feb 1987). Contract W-7405-ENG-82.

We have constructed a large differentially pumped platform for use in ultrahigh vacuum. The design utilizes spring-loaded Teflon seals to permit differential pumping between two horizontal stainless-steel disks. This allows the rotation of the upper disk and the items built into it directly inside a vacuum chamber while maintaining a pressure of $2 \times 10^{-10}$ Torr. The following design parameters are discussed: conductance across the seals, deflection of the seals, rotational friction, and differential thermal expansion during bakeout.

20841 **Surry steam generator - examination and evaluation.** Clark, R.A.; Doctor, P.G.; Ferris, R.H. (Battelle Pacific Northwest Labs., Richland, WA, USA). *Nuclear Engineering and Design;* **98**: No. 2, 123-134(Jan 1987). (CONF-8510173—). Contract AC06-76RL01830.

From 13. water reactor safety research information meeting; Gaithersburg, MD, USA (22 Oct 1985).

This report summarizes research conducted during the fourth year of the five year Steam Generator Group Project. During this period the project conducted numerous nondestructive examination (NDE) round robin inspections of the original Surry 2A steam generator. They included data acquisition/analysis and analysis-only round robins using multifrequency bobbin coil eddy current tests. In addition, the generator was nondestructively examined by alternate or advanced techniques including ultrasonics, optical fiber, profilometry and special eddy current instrumentation. The round robin interpretation data were compared. To validate the NDE results and for tube integrity testing, a selection of tubing samples, determined to be representative of the generator, was designated for removal. Initial sample removals from the generator included three sections of tube sheet, two sections of support plate and encompassed tubes, and a number of straight and U-bend tubing sections. Metallographic examination of these sections was initiated. Details of significant results are presented in the following paper.

20842 **Reliability study on the Lawrence Livermore National Laboratory water-supply system.** Hasegawa, H.K.; Lambert, H.E. (Hazards Control Dept., Lawrence Livermore National Lab., P.O. Box 5505 (L-442), Livermore, CA 94550). pp 611-620 of Fire safety science. Grant, C.E.; Pagni, P.J. New York, NY; Hemisphere Publishing (1986). (CONF-851098—). Contract W-7405-ENG-48.

From International fire safety meeting; Gaithersburg, MD, USA (7 Oct 1985).

The authors conducted a reliability analysis of the Mocho water-supply system for the Lawrence Livermore National Laboratory (LLNL) to determine if an adequate supply of water would be available in the event of a major fire. They used the digraph fault-tree approach for logic model generation. The initiating-enabling event interval reliability approach was used for a probabilistic evaluation of the Mocho system fault tree. In the event of a major fire, the Mocho system demand unavailability was calculated to be 3.6 x 10/sup -4/. They identified 16 single-component failures that would cause failure of the control loop which monitors storage-tank level. These failures would go undetected by monitoring personnel at LLNL. The recommended changes would provide a redundant measurement of the tank level, resulting in a decrease of the predicted system unavailability by about a factor of 50.

20843 **A study of ductile cast iron for use as a spent nuclear fuel shipping cask.** Sorenson, K.B.; Salzbrenner, R. (Sandia National Labs., Albuquerque, NM). pp 415-420 of The mechanism of fracture. Goel, V.S. Metals Park, OH; American Society for Metals (1985). (CONF-851203—).

From International conference and exhibition on fatigue, corrosion cracking, fracture mechanic and failure analysis; Salt Lake City, UT, USA (2 Dec 1985).

The Transporation Technology Center at Sandia National Laboratories is exploring the potential of using ductile cast iron for spent nuclear fuel shipping casks. The program addresses issues which are concerns from a licensing standpoint; specifically, failure modes at low temperatures with impact loading, fracture mechanics properties and validation of analytic codes which model material response of a flawed cask to impact loading. The experimental program is divided into two phases: 1) material characterization of thick section ductile cast iron, and 2) field drop tests of existing full-scale casks. The material characterization tests will define upper and lower shelf failure regions and measure fracture toughness values at impact loading rates. The field drop tests will monitor actual cask response to impact loading in terms of stress levels and crack propagation. The data will be used to benchmark analytic codes and to determine actual crack arrest properties as compared with the fracture toughness values determined in the lab.

20844 **Impact analyses after pipe rupture.** Chun, R.C.; Chuang, T.Y. (Lawrence Livermore National Lab., Livermore, CA). pp 320-330 of Structural impact and crashworthiness. Volume 2. Morton, J. New York, NY; Elsevier Science Pub. Co. Inc. (1984). (CONF-840717—).

From Hazardous waste management; Boston, MA, USA (16 Jul 1984).

The authors successfully reproduce two of the French pipe whip experiments with the computer code WIPS. The WIPS results are in good agreement with the experimental data and the French computer code TEDEL. This justifies the use of its pipe element in conjunction with its U-bar element in a simplified method of impact analyses.

## 4203 Lasers

*REFER ALSO TO CITATION(S) 20809, 20939, 21445, 21866*

20845 **(AD-A—174783/1/XAB) Passive q-switching of $CO_2$ TEA laser using sulfur hexafluoride ($SF_6$). Report for April-August 1986.** Pastel, R. (Army Electronics Research and Development Command, Fort Belvoir, VA (USA). Night Vision and Electro-Optics Labs.). Oct 1986. 20p. (AMSEL-NV-TR—0056). NTIS, PC A02/MF A01.

Passive Q-switching of a $CO_2$ TEA laser using sulfur hexafluoride ($SF_6$) was demonstrated at 10.2 micron. There is minimum loss of peak power, narrowing of the pulse, and elimination of the tail. Q-switching at 9.6 micron was not observed. Also discussed is the use of $SF_6$ to frequency the laser to the strong gain lines of the 10.2-m and 9.6-m branch of the $CO_2$ emission. Both theory and experimental results are given.

20846 **(AD-A—175386/2/XAB) Observation of erasable holographic gratings at room temperature in $Eu^{3+}$-doped glasses.** Behrens, E.G.; Durville, F.M.; Powell, R.C. (Oklahoma State Univ., Stillwater (USA). Dept. of Physics). Oct 1986. 4p. NTIS, PC A02/MF A01.

Published in Optics Letters, Vol. 11, No. 10, 653-655(Oct 1986).

The characteristics of four wave-mixing signals were studied in $Eu^{3+}$-doped glasses. When the $Eu^{3+}$ ions were resonantly excited, two types of laser-induced grating were formed: a transient population grating associated with the excited Eu3+ions and a holographic grating, which was permanent at room temperature but could be erased either thermally or optically.

**20847 (AD-A—175412/6/XAB) Optical feedback-phase stabilization of a semiconductor laser.** Ho, S.; Ezekiel, S.; Haavisto, J.R.; Danko, J.J. (Massachusetts Inst. of Tech., Cambridge (USA). Research Lab. of Electronics). Mar 1986. 5p. NTIS, PC A02/MF A01.

Published in J. of Lightwave Technology, Vol. LT-4, No. 3, 312-315(Mar 1986).

The phase of optical feedback into a semiconductor laser was stabilized to maintain a minimum linewidth of 2 MHz. The scheme makes use of the linewidth information provided by a 1-MHz-width external resonator. A further reduction in the laser linewidth to 300 kHz can be achieved and stabilized by using an external resonator with a narrower width.

**20848 (AD-A—175450/6/XAB) Tunable molecular lasers. Final report.** Eden, J.G.; Guenther, B.D. (Illinois Univ., Urbana (USA). Dept. of Electrical and Computer Engineering). Sep 1986. 62p. (UILU-ENG—86-2556). NTIS, PC A04/MF A01.

Experiments are described in which the potential of dye vapors and HgBr as tunable visible lasers were investigated. As a result of this three-year effort, several significant results were obtained. The B 2-sigma from X 2-sigma absorption band of HgBr at 350 nm was obtained and a near-uv, optically-pumped HgBr laser has been demonstrated. The 502-nm HgBr laser was also successfully flashlamp-pumped. Charge-transfer absorption from HgBr B 2-sigma at lambda approx. 447 nm was observed and the upper state tentatively identified. Intense, stable discharges inPOPOP and coumarin 6 vapor were obtained in a uv-preionized, transverse discharge device. Preliminary gain measurements reveal net absorption.

**20849 (AD-A—175546/1/XAB) Lateral coherence properties of broad-area semiconductor quantum-well lasers.** Larsson, A.; Salzman, J.; Mittelstein, M.; Yariv, A. (California Inst. of Tech., Pasadena (USA)). 1 Jul 1986. 4p. NTIS, PC A02/MF A01.

Published in J. of Applied Physics, Vol. 60, No. 1, 66-68(1 Jul 1986).

The lateral coherence of broad-area lasers fabricated form a GaAs/GaAlAs graded index waveguide separate confinement and single quantum-well heterostructure grown by molecular beam epitaxy was investigated. These lasers exhibit a high degree of coherence along the junction plane, thus producing a stable and very narrow far-field intensity distribution.

**20850 (AD-A—175583/4/XAB) Confocal unstable-resonator semiconductor laser.** Salzman, J.; Lang, R.; Larson, A.; Yariv. (California Inst. of Tech., Pasadena (USA)). Aug 1986. 4p. NTIS, PC A02/MF A01.

Published in Optics Letters, Vol. 11, No. 8, 507-509(Aug 1986).

GaAs/GaA1As heterostructure lasers with a monolithic confocal unstable resonator were demonstrated. The curved mirrors satisfying the confocal condition were fabricated by etching. Close to threshold, the lasers operate in a single lateral mode with a nearly collimated out beam. A single-lobe far-field intensity distribution as narrow as 1.9 deg full width at half maximum was measured.

**20851 (AD-A—175623/8/XAB) Spectrum converter dye for enhancement of blue-green laser efficiency.** Han, K.S.; Oh, C.H.; Lee, J.H. (Hampton Inst., VA (USA). Dept. of Physics and Engineering Studies). 15 Nov 1986. 5p. NTIS, PC A02/MF A01.

Published in J. of Applied Physics, Vol. 60, No. 10, 3414-3416(15 Nov 1986).

To enhance the efficiency of a blue-green laser through spectrum conversion of the pumping light, a converter dye BBQ was mixed in the laser dye solutions. The laser was pumped with a plasma radiation source. The increase of laser output over the maximum obtainable from the pure dye operation was better than 80% for the dye mixture of LD 490 + BBQ or coumarin 503 + BBQ. The estimated enhancement calculated by a simple spectrum-conversion model agrees well with the experimental results. The enhancement is mainly effected by irradiance in the UV from the pumping source, the fairly good match of the fluorescence band of converter dye with the absorption band of the laser dye, and the lack of the overlap of the fluorescence band of the laser dyes with the triplet triplet absorption band of the converter dye used.

**20852 (CEA-CONF—8534) Experimental study of population inversion in laser plasmas.** Bocher, J.L.; Busquet, M.; Combis, M.; Le Breton, J.P.; Louis-Jacquet, M.; Mexmain, J.M.; Naudy, M. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Jun 1986. 12p. (CONF-8606247—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751037.

From GRECO-ILM seminar; Oleron, France (23 Jun 1986).

Thin and thick composite targets of various material (Al, CH, Au) have been irradiated on both circular and linear focal spot with the laser Octal facility at wavelength 1.06 μm and 0.35 μm and laser irradiances ($5.10^{12}$ W/cm² to $5.10^{14}$ W/cm²). X-ray spectra, in the ranges 5-8 A and 15 - 300 A, recorded respectively by means of flat TIAP and grazing incidence spectrographs show an experimental evidence of population inversion in aluminium plasmas.

**20853 (CEA-CONF—8535) X-ray absorption measurements in high-Z laser plasmas.** Combis, M.; Busquet, M.; Louis-Jacquet, M. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Jun 1986. 10p. (CONF-8606247—2). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751038.

From GRECO-ILM seminar; Oleron, France (23 Jun 1986).

Irradiation of structured target by a high intensity laser beam allows the study of X-ray absorption. We present measurements of aluminium spectral resonance lines through a gold plasma.

**20854 (IA—1421, pp 49) Multiple-pass amplifiers for high-power laser systems.** Jackel, S.; Lalluz, R.; Givon, M.; Ludmirsky, A.; Zentner, A.; Eliezer, S.; Borowitz, J.L.; Arad, B.; Zigler, A.; Gazit, Y. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.

In Research laboratories annual report 1985.

**20855 (LBL—22317) Brightness and coherence of synchrotron radiation and high-gain free electron lasers.** Kim, K.J. (Lawrence Berkeley Lab., CA (USA)). Oct 1986. Contract AC03-76SF00098. 25p. (CONF-8606252—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87003525.

From Brightness and coherence of synchrotron radiation and high-gain free electron lasers; Novosibirsk, USSR (3 Jun 1986).

The characteristics of synchrotron radiation are reviewed with particular attention to its phase-space properties and coherence. The transition of the simple undulator radiation to more intense, more coherent high-gain free electron lasers, is discussed.

**20856 (SAND—86-2926C) Pulsed power for high power electron-beam pumped lasers.** Buttram, M.T.; Gerber, R.A. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 11p. (CONF-870132—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004523.

From LASE-13: pulse power for lasers conference; Los Angeles, CA, USA (11 Jan 1987).

A primary consideration for operation of many high power gas lasers is the generation of a high voltage, large area electron beam. Beam parameters are dictated by laser requirements. Historically the electrical system typically has consisted of a Marx generator with pulse shaping stages or a pulse forming line. In the latter case, one or more high voltage switches (spark gaps) are required. Generally, these systems have been single pulse with cold cathode diodes. For repetitive systems, there is a trend to replace the Marx generator with a pulse transformer. For long pulses and large diode impedances, the pulse shaping elements can be placed in the transformer primary circuit. Otherwise, a PFL and high voltage switch are still required. The trend in pulsed power systems is to attempt to increase the range over which the PFL is not required. For short pulses (10's of nanoseconds), cold cathodes provide a stable impedance for at least hundreds of thousands of shots at rates to

several tens of hertz. For longer pulses, where impedance collapse becomes a problem, the shot life of cold cathodes becomes short and the use of hot cathodes may be necessary. In either case, issues of beam current uniformity over large areas (including control of pinching) and mitigation of arc formation must be addressed. This paper will review on-going work relevant to the electrical systems and beam sources. State-of-the-art will be described and a modest attempt will be made to extrapolate current trends.

20857 **Optical properties of $Cr^{3+}$ in fluorite-structure hosts and in $MgF^{*}_{2}$.** Payne, S.A.; Chase, L.L.; Krupke, W.F. (Lawrence Livermore National Laboratory, P.O. Box 5508, Livermore, CA 94550). *Journal of Chemical Physics;* **86**: No. 6, 3455-3461(15 Mar 1987). Contract W-7405-ENG-48.

We have examined the optical properties of $Cr^{3+}$ in $MgF_2$ and in the fluorite-structure hosts: $CdF_2$, $CaF_2$, $SrF_2$, and $BaF_2$. The properties of $Cr^{3+}$ in $MgF_2$ are similar to those observed for other fluoride crystals that have octahedral substitutional metal sites. Interestingly, $Cr^{3+}$ is also found to be sixfold coordinated in the fluorite hosts, despite the fact that the metal sites of these crystal lattices are eightfold coordinated. The smaller ionic radius of $Cr^{3+}$ compared to, say, $Ca^{2+}$, undoubtedly results in considerable relaxation at the metal site. However, the crystal field stabilization energy present in the $^4A_2(d^3)$ ground state also provides for the energetic preference of sixfold vs eightfold coordination. The similarity of the observed absorption spectra of $Cr^{3+}$ in $MgF_2$ and in fluorite give evidence that the ground state is octahedrally coordinated in all of these hosts. The reduction of this electronic stabilization energy in the $^4T_2(d^3)$ excited state is considered to produce a configurational shift relative to the ground state. This shift may be the reason why $Cr^{3+}$ luminesces effectively in $MgF_2$ whereas it is largely quenched in the fluorite-structure materials.

20858 **Sideband control in a millimeter-wave free-electron laser.** Masud, J.; Marshall, T.C.; Schlesinger, S.P.; Yee, F.G.; Fawley, W.M.; Scharlemann, E.T.; Yu, S.S.; Sessler, A.M.; Sternbach, E.J. (Columbia University, New York, New York 10027). *Physical Review Letters;* **58**: No. 8, 763-766(23 Feb 1987).

The frequency offset of the sideband instability in a free-electron laser (FEL) should depend on (1-v/sub X//v/sub g/)/sup -1/, where v/sub X/ is the average longitudinal velocity of the electrons and v/sub g/ is the group velocity of the electromagnetic waves. We have tested the v/sub X//v/sub g/ dependence of the sideband shift in a 2-mm, Raman-regime FEL oscillator. A change of v/sub X//v/sub g/ from 0.93 to 0.98, accomplished by an increase in the undulator period, resulted in the measured sideband shift increasing from 6% to 40%, in approximate agreement with theory.

20859 **Noise-induced switching of photonic logic elements.** Filipowicz, P.; Garrison, J.C.; Meystre, P.; Wright, E.M. (Max-Planck Institut fuer Quantenoptik, D-8046 Garching bei Muenchen, Federal Republic of Germany). *Physical Review [Section] A: General Physics;* **35**: No. 3, 1172-1180(1 Feb 1987).

We study the stability of optical bistable elements against holding-field noise by considering the specific case of a purely dispersive Kerr medium. For small devices, i.e., those for which the round-trip time is small compared to the material-response time, we show that operation of an optical switch with a holding-field intensity a few percent away from the switching value will not be subject to problems due to the noise in the holding laser. This is due to the extremely rapid increase of the average time between noise-induced switching events as the distance, in intensity, from the switching point increases. White noise or Ornstein-Uhlenbeck noise models are not sufficiently smooth for a correct description of this problem, and so we use a more elaborate colored-noise model to evaluate the diffusion constant in the Fokker-Planck equation for the nonlinear phase shift. The time between switching events is then obtained by solving a first-passage-time problem.

20860 **Cold relativistic helically symmetric steady flows.** Weitzner, H.; Fruchtman, A.; Amendt, P. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). *Physics of Fluids;* **30**: No. 2, 539-547(Feb 1987).

A general theory of nontenuous cold relativistic helically symmetric steady flows is developed. Both self-fields and radial effects are included. The fluid and the Maxwell equations are reduced to a system of equations for three scalar functions: a stream function, a flux function, and an electrostatic potential. These equations are expanded under the assumption of small perpendicular momenta and a simplified set of ordinary differential equations is obtained. Two cases are studied in detail. The first case is of a system externally driven by a magnetic wiggler. The second is the self-excited system, with no externally applied wiggler. The equilibria described here are of a practical importance for free-electron lasers which employ high-density thick beams.

20861 **Dual beam translator for use in laser doppler anemometry.** Brudnoy, D.M. (to Dept. of Energy, Washington, DC). US Patent 4,637,717. 20 Jan 1987. Filed date 12 Apr 1984. vp.

A method is described for attaining substantial spacial coincidence of the intersection volumes of two pairs of intersecting light beams in a fluid flow conduit in a Doppler anemometry device. The method comprises focusing the two pairs of light beams with a beam focusing means and selectively translating the beam paths of at least one of the pairs of beams. The paths are translated in a direction parallel to the original beam paths by a pair of rotatable transparent optical means provided in the beam paths between the beam focusing means and the fluid flow conduit.

20862 **Polarization feedback stabilization of an injection-seeded Nd:YAG laser for spectroscopic applications.** Esherick, P.; Owyoung, A. (Advanced Laser Technology Division 1124, Sandia National Laboratories, Albuquerque, New Mexico 87185-5800). *Journal of the Optical Society of America B: Optical Physics;* **4**: No. 1, 41-47(Jan 1987). Contract AC04-76DP00789.

We have achieved reliable operation of a tunable, single-mode injection-seeded Nd:YAG laser that incorporates a novel feedback scheme to maintain the required match between the master- and slave-resonator cavity lengths. The reliability of the system is illustrated by both fluorescence excitation and sub-Doppler polarization spectra of $I_2$ taken with the second-harmonic output of the slave laser while temperature tuning the injected frequency from the master oscillator. These spectra should provide extremely useful for long-term stabilization of the system to an absolute frequency reference.

20863 **Critical review of gamma-ray laser proposals.** Baldwin, G.C. (Los Alamos National Laboratory, Los Alamos NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 6-9(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

Laser sources generating sub-nm radiation, using recoilless nuclear transitions in solids, have been proposed for years. This review examines, from the standpoint of kinetics, many solutions (viz., narrowed line, explosive neutron pump, two-stage pump, two-step pump) that have been proposed for the basic problem: that pumping can inhibit or destroy the Mossbauer and Borrmann effects, which are essential for gain.

20864 **Nuclear structure properties for gamma-ray lasers.** Strottman, D.; Arthur, E.D.; Madland, D.G. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 14-17(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

We summarize some initial results in our investigation of the nuclear physics issues of gamma-ray lasers. We describe what is

known thus far from existing experimental data and illustrate how theoretical models may be employed for systematic searches of candidate nuclei.

20865 **Interlevel transfer mechanisms and their application to grasers.** Solem, J.C. (Los Alamos National Laboratory, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 22-25(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

Within the gamma-ray laser (GRASER) research community, much attention is being given to two-step schemes that store energy in a long-lived isomeric state and achieve lasing by transferring population to a short-lived state. Because the electron system exhibits large multipole moments and is in the near field of the nucelus, it can be used as an intermediate mechanism for transferring energy, angular momentum, and parity change. Two distinct electron-nucleus interaction mechanisms are discussed: (1) resonant electronic transitions and (2) collective outer-shell excitations.

20866 **Kinetics of nuclear superradiance.** Baldwin, G.C.; Feld, M.S. (Los Alamos National Laboratory, Physics Division, Los Alamos, New Mexico 87545). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 26-30(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

The feasibility of achieving laser action in the gamma radiation range is discussed. The possible mechanisms pumping, and the rapid transfer of active nuclei into the upper laser level are discussed. An analysis of kinetics of superradiant nuclear gamma-ray emission is given.

20867 **Activities at LLNL relevant to gamma-ray laser concepts.** Dietrich, F.S. (Lawrence Livemore National Laboratory, Livermore, CA 94550). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 31-32(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

Current and planned gamma-ray laser activities at Lawrence Livermore National Laboratory are discussed. The construction of a new accelerator laboratory that will include a facility for gamma-ray laser candidate searches is also discussed.

20868 **Nuclear excitation through the dynamic hyperfine effect.** Rinker, G. (T-1, Los Alamos National Laboratory, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 48-49(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

Calculational methods developed for muonic atoms have been applied to the problem of nuclear interlevel transfer via resonant electronic states. Nuclear excitation probabilities as large as a few percent have been found. The most promising circumstances for the pumping of gamma-ray lasers will be discussed.

20869 **Possibility of grasing by laser-driven nuclear excitation.** Biedenharn, L.C.; Boyer, K.; Solem, J.C. (Los Alamos National Laboratory, Theoretical Division, MS B210, Los Alamos, New Mexico 87545). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 50-51(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

$^{235}U$ is considered as a possible gamma-ray laser candidate via a pumping mechanism of sequential laser-driven coherent oscillations of outer atomic shells and the coupling by way of nuclear multiple moments to produce nuclear excitation of the 73 EV first excited state.

20870 **Nuclear excitation by laser driven coherent outer shell electron oscillations.** Biedenharn, L.C.; Baldwin, G.C.; Boyer, K. (Los Alamos National Laboratory, Theoretical Division, MS B210, Los Alamos, New Mexico 87545). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 52-53(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

It is emphasized that laser driven coherent multielectron oscillations of the outer electron shell will offer a suitable pumping mechanism to achieve nuclear excitation for probable lasing in the gamma radiation range. $^{235}U$ is discussed for such a possible excitation.

20871 **Assessment of a method proposed for finding transfer levels for isomeric deexcitations.** Haight, R.C.; Baldwin, G.C. (Los Alamos National Laboratory, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 58-59(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

The existence of closely spaced nuclear levels with disparate lifetimes is an essential feature of recent proposals for gamma-ray lasers. Resolving such pairs of levels is beyond the present capabilities of nuclear spectroscopy. In this work, we consider the possibility that exposure of an isomer to a continuum of radiation, specifically a pulse of black body radiation produced by a laser, would reveal the second level. We compare the required couplings of the nucleus to the photon field with those observed. We conclude that this method probably is not appropriate for finding transfer levels.

20872 **Predicted changes of the internal conversion rates in /sup 119/Sn due to admixtures of lower multipole order.** Wender, S.A.; Baldwin, G.C.; Talbert, W.L.; Reiss, H.R. (Los Alamos National Laboratory, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 70-71(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

One conceivable basis for interlevel transfer from a long-lived isomer to graser state might be to alter the multipolarity of the transfer step. As an example, in the case of /sup 119/Sn any mechanism that introduces angular momentum to admix M3 radiation into the normally M4 transition from the 89.6 keV, $11/2^-$ level to the 23.9 keV $3/2^+$ state could greatly shorten its normal 293 day halflife. We have calculated the K-shell internal conversion rate for the 89.6 keV level in /sup 119/Sn for small admixtures of M3 radiation using Moszkowski formulas for the radiative transition rates and tabulated values of the internal conversion coefficients. We find that even very small admixtures of lower multipole order can produce very large changes in the internal conversion coefficient. This offers the basis for a simple and definitive test of the hypothesized mechanism for creating population inversion by introducing angular momentum.

20873 **Stimulated soft x-ray emission in a confined plasma column.** Suckewer, S.; Skinner, C.H.; Keane, C.; Kim, D.; Schwob, J.L.; Valeo, E.; Voorhees, D.; Wouters, A. (Plasma Physics Laboratory, Princeton University, Princeton, NJ 08544). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 81-86(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

Measurements of high gain on the CVI 182 A line are compared to theoretical predictions of a 1D code. Spectra of the emissions in axial and transverse directions, obtained with recently installed multichannel detectors, are presented. A new two-laser approach to generating gain at wavelengths below 100 A is described.

20874 **Optical properties of $LaMgAl_{11}O_{19}$:Cr,Nd.** Shinn, M.D.; Krupke, W.F.; Caird, J.A.; Newkirk, H.W. (Lawrence Livermore National Laboratory, P.O. Box 5508, Livermore, CA 94550). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 216-217(15 Aug 1986). (CONF-851185—). Contract W-7405-ENG-48.

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

The optical properties of Cr-doped $LaMgAl_{11}O_{19}$ (LMAO:Cr) and LMAO:Cr,Nd have been measured. Evidence of Cr to Nd radiationless energy transfer was observed. Since LMAO:Nd may become a useful laser material, the prospect of further improving laser performance through Cr-sensitization is discussed.

20875 **GSGG crystal growth and quality: a status report.** Stokowski, S.; Caird, J.; Shinn, M.; Smith, L.; Wilder, R. (Lawrence Livermore National Laboratory, Livermore, CA 94550). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 225-226(15 Aug 1986). (CONF-851185—). Contract W-7405-ENG-48.

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

Gadolinium scandium gallium garnet (GSGG) co-doped with Cr and Nd is the crystalline-laser material with the highest measured efficiency (5% absolute) under flashlamp pumping. It is presently being developed for a variety of laser applications. We report measurements of the present crystal quality of 1.5 to 2-inch diameter boules, finding 0.24 $m^{-1}$ loss coefficient; $\lambda/50$ homogeneity in a 1/4-inch by 3-inch rod; and 0.4 nm/cm, birefringence. We have evidence that a one-micron absorption band, which appears frequently in Cr doped GSGG, is caused by $Cr^{4+}$, which is generated to compensate for $Ca^{2+}$ impurities in the crystal. Scale-up boule growth to 5-inch diameter is now underway.

20876 **Development of high strength state laser materials.** Marion, J.E. (Lawrence Livermore National Laboratory, Livermore, CA 94550). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 234-236(15 Aug 1986). (CONF-851185—). Contract W-7405-ENG-48.

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

The threat of laser material fracture limits the average power of many laser to modest levels. Rupture occurs when the tensile surface stress, which results from the temperature gradient within the component, exceeds its strength. To increase the power output potential we have focussed on methods to strengthen the amplifier slabs. Two basic approaches are used; the subsurface damage from machining, and inducing a compressive stress at the slab surface. We report results on several strengthened systems including GSGG, GGG and YAG crystalline hosts, and LHG-5 phosphate glass (Hoya Glass Corp.).

20877 **Spectroscopic, optical, and thermo-mechanical properties of GSGG and its laser performance.** Krupke, W.F. (Lawrence Livermore National Laboratory, Livermore, CA 94550). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 239-242(15 Aug 1986). (CONF-851185—). Contract W-7405-ENG-48.

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

Spectroscopic, optical, and thermo-mechanical properties central to the design of high average power Nd:Cr:GSGG lasers are presented. The status of crystal growth and achieved laser performance levels are briefly reviewed.

20878 **Laser induced damage in optical materials: 1983.** Bennett, H.E.; Guenther, A.H.; Milam, D.; Newman, B.E. Washington, DC; Government Printing Office (1985). 552p. (CONF-8311146—).

From Symposium on optical materials for high power lasers; Boulder, CO, USA (14 Nov 1983).

This book presents the papers given at a conference on the testing of laser materials. Topics considered at the conference included the optical and mechanical properties of glasses, laser damage in plastics, damage thresholds, optical surfaces, laser mirrors, the round-robin testing of low-scatter optics, light scattering characteristics of metal surfaces, microroughness and static density variations, bulk dielectric permittivity, laser wavelength, pulse duration, film thickness, RF-sputtered laser coatings, ion-beam sputtering, phase shift variations, antireflection films, nonlinear effects, and the refractivity of semiconductors.

20879 **Catastrophic versus microscopic damage: Applicability of laboratory measurements to real systems.** Foltyn, S.R.; Jolin, L.J. (Los Alamos National Lab., Los Alamos, NM). pp 493-501 of Laser induced damage in optical materials: 1983. Bennett, H.E.; Guenther, A.H.; Milam, D.; Newnam, B.E. Washington, DC; US Government Printing Office (1985). (CONF-8311146—).

From Symposium on optical materials for high power lasers; Boulder, CO, USA (14 Nov 1983).

At ultraviolet wavelengths, damage to both coatings and bare surfaces is dominated by the presence of discrete localized defects. During multiple-shot irradiation, the overwhelming majority of these defects are damaged by the first or first few shots. Initially, damage morphology is that of a crater of approximately 10 $\mu$m in diameter; however, upon continued irradiation, one of two events can occur: either the crater grows to catastrophic dimensions or it remains unchanged. In the latter case, the damage is only observable under a microscope, it may be indistinguishable from cosmetic defects present before irradiation, and it is likely that any related degradation in optical performance is unmeasurable. In view of the generally accepted definition of laser damage (i.e., any visible change in the surface), it is important to consider the implications for real systems. These are discussed in the context of ultraviolet test results for both coatings and surfaces.

20880 **Predamage threshold electron emission from insulator and semiconductor surfaces.** Siekhaus, W.J.; Kinney, J.H.; Milam, D. (Lawrence Livermore National Lab., Livermore, CA). pp 442-447 of Laser induced damage in optical materials: 1983. Bennett, H.E.; Guenther, A.H.; Milam, D.; Newman, B.E. Washington, DC; Government Printing Office (1985). (CONF-8311146—).

From Symposium on optical materials for high power lasers; Boulder, CO, USA (14 Nov 1983).

Predamage electron emission shows a dependence on fluence, bandgap and wavelength consistent with multiphoton excitation across the bandgap and inconsistent with avalanche ionization and thermionic emission models. The electron emission scales with pulselength as tau/sup -1/2/.

20881 **Laser damage in porous-silica antireflection films.** Lowdermilk, W.H.; Wilder, J.G.; Brown, N.J.; Gunderson, C.A. (Lawrence Livermore National Lab., Livermore, CA). pp 372-377 of Laser induced damage in optical materials: 1983. Bennett, H.E.; Guenther, A.H.; Milam, D.; Newnam, B.E. Washington, DC; US Government Printing Office (1985). (CONF-8311146—). Contract W-7405-ENG-48.

From Symposium on optical materials for high power lasers; Boulder, CO, USA (14 Nov 1983).

The authors used 355-nm, 0.6-ns pulses to measure laser-damage thresholds of porous-silica antireflection coatings deposited from a polymer solution onto fused silica substrates. For 118 coatings with optical thickness of 500-600 nm, the median threshold was less than 2 J/cm/sup 2/, and thresholds were not systematically dependent on either the level of filtration of the coating solution or the procedure used to clean the substrates. For coatings 87-90 nm in optical thickness, thresholds were as large as 9 J/cm/sup 2/, which is the threshold of the bare polished surfaces of the fused silica substrates. The data suggests that carbon residues from the coating solution are responsible for damage in the thicker coatings.

20882 **Alumina/silica multilayer coatings for excimer lasers.** Foltyn, S.R.; Jolin, L.J. (Los Alamos National Lab., Los Alamos, NM). pp 354-359 of Laser induced damage in optical materials: 1983. Bennett, H.E.; Guenther, A.H.; Milam, D.; Newman, B.E. Washington, DC; Government Printing Office (1985). (CONF-8311146—).

From Symposium on optical materials for high power lasers; Boulder, CO, USA (14 Nov 1983).

The coating parameter that most strongly influences optical damage resistance is the choice of materials used to produce a component. During the course of testing of hundreds of ultraviolet reflectors involving 12 different material combinations, multilayer stacks of Al/sub 2/O/sub 3//SiO/sub 2/ have demonstrated a superior ability to resist laser-induced damage. Further, damage thresholds for these coatings are at least twice as high as for reflectors composed of other materials: In particular, thresholds of 6 J/cm/sup 2/ at 248 nm (15 ns) and 12 J/cm/sup 2/ at 351 nm (12 ns) have been measured. Comparative results are presented for a variety of materials at both wavelengths as are preliminary results for alumina-based antireflective coatings.

20883 **Recent damage results on high reflector coatings at 355 nm.** Carniglia, C.K.; Hart, T.T.; Rainer, F.; Staggs, M.C. (Optical Coating Lab., Inc., 2789 Northpoint Parkway, Santa Rosa, CA). pp 347-353 of Laser induced damage in optical materials: 1983. Bennett, H.E.; Guenther, A.H.; Milam, D.; Newnam, B.E. Washington, DC; US Government Printing Office (1985). (CONF-8311146—).

From Symposium on optical materials for high power lasers; Boulder, CO, USA (14 Nov 1983).

Several studies of damage induced by 0.6 ns, 355 nm laser pulses have been carried out on thin-film reflectors. The reflectors consisted of dielectric materials vacuum-deposited onto BK7 substrate by evaporation. Each part was damage tested on several sites using one laser shot per site. Quarterwave stacks of various material combinations were used to make a series of reflectors. Four to six parts were tested for each of four materials combinations. The average damage thresholds obtained for these coatings were 3.5 J/sq. cm for scandia/magnesium fluoride, 3.0 J/sq. cm for zirconia/silica, 2.4 J/sq. cm for tantala/silica and 1 J/sq. cm for hafnia/silica. Interestingly, there was no improvement in those reflectors to which a halfwave silica overcoat was added. This is contrary to previous results at 1064 nm and 248 nm. A series of zirconia/silica reflectors was made using coating temperatures ranging from 150°C to 300°C. The thresholds were slightly improved by coating at higher temperatures. Coatings made of zirconia/silica with outer quarterwave layers of samarium fluoride and either silica or magnesium fluoride were also tested. Thresholds for these coatings ranged from 1.7 to 2.8 J/sq. cm and were slightly lower than the thresholds of the zirconia/silica stacks alone. Scandia/magnesium fluoride coatings with non-quarterwave designs have been shown to be effective in raising the damage threshold of high reflectors at 248 nm. Such designs reduce the electric field intensity in the outer scandia layers. The damage thresholds of several non-quarterwave designs were compared. The highest threshold, 5.1 J/sq. cm, was achieved by reducing the electric field in the two outer scandia layers.

20884 **Recent damage results for antireflection coatings at 355 nm.** Hart, T.T.; Carniglia, C.K.; Rainer, F.; Staggs, M.C. (Optical Coating Lab., Inc., 2789 Northpoint Parkway, Santa Rosa, CA). pp 340-346 of Laser induced damage in optical materials: 1983. Bennett, H.E.; Guenther, A.H.; Milam, D.; Newnam, B.E. Washington, DC; US Government Printing Office (1985). (CONF-8311146—).

From Symposium on optical materials for high power lasers; Boulder, CO, USA (14 Nov 1983).

High-index and low-index thin-film antireflection (AR) coatings for use at 355 nm have been tested to determine their resistance to laser damage. All coatings consisted of dielectric materials which were vacuum deposited onto bowl-feed polished Suprasil II by evaporation. Laser damage studies were made by irradiating several sites on each sample with a 0.6 ns, 355 nm laser pulse. Each site was irradiated by only one pulse. High-index coatings were made with both a high-index material and a low-index material. The high-index materials chosen for this study were scandia (Sc/sub 2/O/sub 3/), hafnia (HfO/sub 2/), and zirconia (ZrO/sub 2/), while the low-index materials were silica (SiO/sub 2/) and magnesium fluoride (MgF/sub 2/). All coatings had four non-quarterwave thick layers plus a halfwave thick undercoat (barrier layer) of the low-index material. Average damage threshold values for four samples of each type ranged from 2.4 J/sq. cm to 3.1 J/sq. cm. Coatings made from scandia/magnesium fluoride had the highest damage thresholds. Low-index coatings contained only low-index materials. The low-index materials chosen for this study were samarium fluoride (SmF/sub 3/), lanthanum fluoride (LaF/sub 3/) thorium fluoride (ThF/sub 4/), silica, magnesium fluoride, and lithium fluoride (LiF). AR coatings containing three to six quarterwave-thick layers plus a halfwave-thick barrier layer were made from nine combinations of these six materials. Average damage threshold values for four to six samples of each type ranged from < 1.0 J/sq. cm to 2.8 J/sq. cm. Coatings made from samarium fluoride/magnesium fluoride had the highest damage thresholds. One set of four scandia/silica coatings was measured at both 355 nm and 248 nm. Damage thresholds at 248 nm for these parts were determined using 20 ns laser pulses. The average threshold was 4.2 J/sq. cm.

20885 **Measurements of the dependence of damage thresholds on laser wavelength, pulse duration and film thickness.** Rainer, F.; Vercimak, C.L.; Carniglia, C.K.; Milam, D.; Hart, T.T. (Lawrence Livermore National Lab., Livermore, CA). pp 268-276 of Laser induced damage in optical materials: 1983. Bennett, H.E.; Guenther, A.H.; Milam, D.; Newnam, B.E. Washington, DC; US Government Printing Office (1985). (CONF-8311146—). Contract W-7405-ENG-48.

From Symposium on optical materials for high power lasers; Boulder, CO, USA (14 Nov 1983).

Results of three experiments are described. The authors used 351-nm and 355-nm pulses with durations of 0.6, 1, 5 and 9 ns to measure thresholds for a variety of antireflectance and high reflectance coatings. The functional form t/sup m/, with t the pulse duration, was used to scale fluence thresholds measured at 0.6 ns to those measured at 9.0 ns. Values of the coefficient m ranged from 0.10 to 0.51. The average value was 0.30. In the second experiment, they measured thresholds at 1064 nm, 527 nm and 355 nm for single-frequency high reflectance ZrO/sub 2//SiO/sub 2/ coatings. Coatings for all three frequencies were deposited simultaneously by use of masks in the coating chamber. Thresholds varied from 2-4 J/cm/sup 2/ at 355 nm to 7-10 J/cm/sup 2/ at 1064 nm. The third experiment measured thresholds at 355 nm for antireflection coatings made with layer thicknesses varying from greater than one wavelength to less than a quarterwavelength. A significant variation of threshold with coating thickness was not observed, but the median thresholds increased slightly as coating thickness increased.

20886 **Damage thresholds of fused silica, plastics and KDP crystals measured with 0.6-ns 355-nm pulses.** Staggs, M.C.; Rainer, F. (Lawrence Livermore National Lab., Livermore, CA). pp 84-90 of Laser induced damage in optical materials: 1983. Bennett, H.E.; Guenther, A.H.; Milam, D.; Newnam, B.E. Washington, DC; US Government Printing Office (1985). (CONF-8311146—). Contract W-7405-ENG-48.

From Symposium on optical materials for high power lasers; Boulder, CO, USA (14 Nov 1983).

The authors used 355-nm, 0.6-ns pulses focused to a beam diameter of approximately 1 mm to measure the laser damage thresholds for surfaces of bare polished samples of several types of fused silica, for the bulk of crystals of potassium dihydrogen phosphate (KDP), and for a few plastics. Surface damage thresholds for fused silica ranged from 1-14 J/cm/sup 2/, and were least for surfaces with residual subsurface polishing fractures. Thresholds for inclusion damage in KDP crystals were 2-4 J/cm/sup 2/. Test volumes in these same crystals had thresholds from 2.5-7.0 J/cm/sup 2/ when they were laser hardened by repeated subthreshold irradiation. FEP teflon films had thresholds of 3 J/cm/sup 2/, which were the greatest threshold observed for a plastic.

20887 **Beam profiling in gigawatt 1064-nm lasers used in research on optical materials at Livermore.** Milam, D.; Peluso, S.E. (Lawrence Livermore National Lab., CA). *Proceedings of the Society of Photo-Optical Instrumentation Engineers;* **499**: 48-55(1985). Contract W-7405-ENG-48.

Laser pulses with intensities ranging from $10^9$-$10^{11}$ watts/cm$^2$ are routinely used at Livermore to measure nonlinear properties of optical materials. The energy in each of these pulses is measured with an absorbing glass calorimeter. Both vidicon cameras and photographic emulsions are used to record the fluence distribution in laser beams. Pulse waveforms are recorded by a streak camera, or by a combination of a photodiode and an oscilloscope. This

paper describes the authors procedures for using this data to determine the fluence and intensity for short duration laser pulses. 5 references, 6 figures.

20888 **Optical feedback, wavelength response, and interference effects of self-pumped phase conjugation in $BaTiO_3$.** Jahoda, F.C.; Weber, P.G.; Feinberg, J. (Los Alamos National Lab., NM). *Optics Letters;* 9: No. 8, 362-364(Aug 1984).

It is shown that even slight optical feedback of a self-pumped phase-conjugate signal into dye or argon-ion lasers causes laser wavelength and conjugator reflectivity changes. The wavelength dependence of the self-pumped phase-conjugate reflectivity in barium titanate is examined over most of the visible spectrum. It is also demonstrated that interference between two collinear beams incident upon the conjugator affects the behavior of the phase-conjugate mirror. 7 references, 4 figures.

20889 **Inductively stabilized excimer lasers.** Sze, R.C. (Los Alamos National Lab., NM). *Proceedings of the International Conference on Lasers;* 512-517(1983).

This paper presents an approach to solving the problem of rare-gas halide avalanche discharge stability. The development of a segmented electrode structure with each element ballasted by an inductor has resulted in very stable discharges and long pulse length laser outputs. The passive stabilization of the rare-gas halide discharges is attributed mainly to the increase in voltage drop across the inductor of a particular segment of the electrode as the discharge in that region begins to go unstable. The advantage of the technique is that the very fast voltage risetime requirement is no longer essential, and the use of conventional thyratron switches without subsequent pulse sharpening circuits is now possible. Presently only small laser devices have been constructed. The 20-cm active length lasers have produced laser pulse lengths greater than 200 ns with efficiencies as high as 1%. Since the intracavity powers for the long-pulsed, short gain length devices are in the region of 200 kW, an order of magnitude below the saturation powers of rare-gas halide lasers, much improved extraction efficiencies are anticipated for longer gain length devices. The small long pulse lasers find applications in injection-locking energy short pulsed lasers in the regenerative amplifier mode without worry of jitter between the two devices. XeCl, XeF, KrF short pulse lasers have all been injection-locked in this manner giving high energy outputs with beam quality approximately three times diffraction limited. In addition simple prism tuning has resulted in 0.6-1 wavenumber linewidths throughout the the XeCl bandwidth and appears to give an improvement of 50 over short pulse lasers for an equivalent tuning chain.

## 4204 Heat Transfer And Fluid Flow

*REFER ALSO TO CITATION(S) 20811*

20890 **(CETIM—03210) Improving the CASTOR software used for transient thermal regime analyses. Final report.** Chaudouet, A. (Centre Technique des Industries Mecaniques, Senlis (France)). Aug 1985. 94p. (In French). (ETN—86-98447). NTIS, PC A05/MF A01.

The choice of network elements and time intervals in a three dimensional boundary integral equation method is analyzed. It is shown that errors may appear when carrying out transient thermal analysis by this method if the choice criteria of networking and time interval are not respected. The presented algorithms allow the volume integration and the localization of the reference network points. A good accuracy of thermal analysis for given boundary conditions and material parameters is obtained.

20891 **(DOE/ER/13081—T1) An experimental investigation of the heat-transfer effects of a longitudinal vortex embedded in a turbulent boundary layer.** Eibeck, P.A.; Eaton, J.K. (Stanford Univ., CA (USA). Thermosciences Div.). Nov 1985. Contract AS03-83ER13081. 136p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87006003.

Longitudinal vortices occur in numerous flow situations in which heat transfer is of considerable importance, such as on the endwalls and blade surfaces of turbine cascades. Previous research implies that the heat transfer rate is increased in the region of these vortices. However, most of these investigations have involved complex turbulent flows in which the longitudinal vortices are just a small component of the total flow configuration. The purpose of this experimental investigation is to isolate the specific effects of longitudinal vortices on heat transfer by embedding a single longitudinal vortex in an otherwise two-dimensional turbulent boundary layer. By obtaining spatially resolved heat transfer measurements and detailed fluid mechanical data, the local effects of the longitudinal vortices on the transfer rate will be determined, as well as the fluid dynamic mechanisms which cause these changes.

20892 **(DOE/ER/13081—T2) [Heat transfer effects of longitudinal vortices embedded in a turbulent boundary layer]: Final report.** Eaton, J.K. (Stanford Univ., CA (USA). Dept. of Mechanical Engineering). 31 Aug 1986. Contract AS03-83ER13081. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006002.

The objective of the present experiment is to study a stronger boundary layer perturbation induced by a vortex pair rather than a single vortex. The data include spatially resolved heat transfer measurements as well as detailed measurements of all six components of the Reynolds stress tensor. The data focus on the variations of the boundary layer structure which are caused by the vortex. This paper presents the heat transfer and skin friction data for several vortex pair cases along with detailed boundary layer velocity profiles for one case.

20893 **(DOE/ER/13489—1) An investigation of the closure conditions for two-fluid models of two-phase flow: Progress report for the period 1 April 1986-31 March 1987.** Lahey, R.T. Jr.; Drew, D.A. (Rensselaer Polytechnic Inst., Troy, NY (USA)). Jan 1987. Contract FG02-86ER13489. 62p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87004792.

The purpose of this research is to develop methodology which can be used to assess various two-phase flow closure laws. Two-phase entropy conservation equations are derived and verified using a three-dimensional cell model. Derivation of the cell models hydrodynamic constitutive equations is included. (LEW)

20894 **(DOE/ER/13553—1) Turbulent premixed flame study: Annual progress report, year 1.** (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). 1986. Contract FG02-86ER13553. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006255.

A three year combined experimental and theoretical effort to study the behavior of turbulent premixed flames was started in July 1986. This effort is a continuation of an earlier program in which the propagation properties of spherical turbulent premixed flame had been studied in detail. The specific objectives of the experimental component in the current program are to examine the dynamic behavior of the flame structures and to study the effects of external aerodynamics on a propagating spherical flame ball in the wrinkled laminar flame regime. In the theoretical effort, the objective is to formulate and exercise a statistical model based on the dynamics of the flame surfaces. Then the detailed statistical data from the experiment will be compared with the model to elucidate the underlining physical principles.

20895 **(ESA-SP—65) Proceedings of an international symposium on fluid dynamics and space.** Burke, W.R. (European Space Agency, 75 - Paris (France)). Aug 1986. 205p. (ETN—87-98893; CONF-8606280—). NTIS, PC A10/MF A01.

From International symposium on fluid dynamics and space; Rhode-Saint-Genese, Belgium (25 Jun 1986).

Organized by ESA, and the Von Karman Inst. for Fluid Dynamics.

Reentry aerothermodynamics; rocket engines; spacecraft environments; and fluid dynamic experiments in space were discussed.

20896 **(EUR—10230) Outline of a numerical method for solving transient equations for multidimensional two-phase flow through a porous medium.** Ruel, F. (Commission of the European Communities, Ispra (Italy). Joint Research Centre; Commission of the European Communities, Luxembourg). 1985. 37p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751019.

A mathematical method has been developed to solve the equations of a model for the cooling of self-heated particle beds. The model involves coupled equations describing the transport of mass and energy by single or two-phase coolant flow in a porous medium. Both transient and steady-state situations are treated in one or two dimensions of space. Specific techniques have been developed to tackle this problem which is of highly non-linear character. We have tried to separate to a large extent the physics and the numerics, keeping the maximum of flexibility at the stage of discretization, and postponing the difficulties to the solution of the final set of non-linear algebraic equations. This flexibility is important as the physical model is mutually coupled to an experimental program still going on. The method has shown to be reliable in the range of parameters we have explored so far, and has relieved us of difficulties commonly encountered when dealing with multiphase flow problems. A computer program called "PAHR-2D" applies the method. The program has been written as a support to the in-pile Post Accident Heat Removal (PAHR) experimental programme. The scope is to assess the coolability of debris beds, to be assumed formed after a hypothetical core disruptive accident of a LMFBR. 5 refs.

20897 **(IAEA-R—2954-F) Heat transfer investigations within dry spent fuel casks. Final report for the period 1 November 1981-31 March 1986.** (International Atomic Energy Agency, Vienna (Austria)). Jul 1986. 30p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700883.

For studying the heat transfer processes and predicting the maximum spent fuel element surface temperature in a spent fuel assembly (SFA) transported in a dry cask, model experiments have been performed with a gas-filled model cask containing a simplified electrically heated model of a WWER-type SFA with 90 fuel elements. The temperature distribution of the SFA model is measured for different heat rates under vacuum in the model cask, and under normal pressure and overpressure (0.1 ... 0.7 MPa) for several cooling gases (air, argon, helium) in order to separately investigate heat transfer processes by radiation and convection/conduction. The measuring results were compared with the calculations. Computer programmes as well as simplified calculation methods for temperature prediction were developed and checked. The results obtained are also useful for thermal analyses in the field of the dry storage of SFAs in a cask or can. Specifically it was found that: The heat removal from the SFA can be considerably improved by increasing the internal cask pressure or by using helium as coolant. The radiant heat exchange in the SFA model can be calculated with sufficient accuracy by means of a computer programme developed in 1978 or by means of a simplified analytical representation shown in the final report. Both methods are directly applicable to the original SFA and useful in order to approximately calculate the maximum SFE surface temperature under normal pressure, if the fraction of heat transferred by radiation is allowed for. For the calculation of the total heat transfer a computer programme was developed and verified, which completely permits the temperature prediction of the SFA model in dependence on heat rate, type of gaseous coolant and coolant pressure. This computer programme can be directly applied to the original SFA for the calculation of the maximum SFE surface temperature. 8 refs, figs.

20898 **(N—87-13661) Turbine vane external heat transfer. Volume 2. Numerical solutions of the Navier-Stokes equations for two- and three-dimensional turbine cascades with heat transfer. Final report.** Yang, R.J.; Weinberg, B.C.; Shamroth, S.J.; Mcdonald, H. (General Motors Corp., Indianapolis, IN (USA)). Jul 1985. 160p. (NASA-CR—174828; NAS—1.26:174828). NTIS, PC A08/MF A01.

The application of the time-dependent ensemble-averaged Navier-Stokes equations to transonic turbine cascade flow fields was examined. In particular, efforts focused on an assessment of the procedure in conjunction with a suitable turbulence model to calculate steady turbine flow fields using an O-type coordinate system. Three cascade configurations were considered. Comparisons were made between the predicted and measured surface pressures and heat transfer distributions wherever available. In general, the pressure predictions were in good agreement with the data. Heat transfer calculations also showed good agreement when an empirical transition model was used. However, further work in the development of laminar-turbulent transitional models is indicated. The calculations showed most of the known features associated with turbine cascade flow fields. These results indicate the ability of the Navier-Stokes analysis to predict, in reasonable amounts of computation time, the surface pressure distribution, heat transfer rates, and viscous flow development for turbine cascades operating at realistic conditions.

20899 **(N—87-13662) Analysis of boundary conditions for SSME subsonic internal viscous flow analysis.** Baker, A.J. (Computational Mechanics Consultants, Knoxville, TN (USA)). Oct 1986. 14p. (NASA-CR—178950; NAS—1.26:178950; COMCO-TR—87-4.0). NTIS, PC A02/MF A01.

A study was completed of mathematically proper boundary conditions for unique numerical solution of internal, viscous, subsonic flows in the space shuttle main engine. The study has concentrated on well posed considerations, with emphasis on computational efficiency and numerically stable boundary condition statements. The method of implementing the established boundary conditions is applicable to a wide variety of finite difference and finite element codes, as demonstrated.

20900 **(N—87-14247) Proceedings of the 3rd NAL Symposium on Aircraft Computational Aerodynamics.** (National Aerospace Lab., Chofu, Tokyo (Japan)). Nov 1985. 266p. (NAL-SP—5). NTIS, PC A12/MF A01.

Special Publication of the National Aerospace Lab.

Topics addressed include: computational fluid dynamics, aerodynamic characteristics, wing and airfoil design, wake structure, numerical grid generation, wind tunnel tests, Navier-Stokes equations, laminar flow control, boundary condition effects, flow simulation, nozzle geometry, supercomputers, and aircraft icing.

20901 **(N—87-14247) VP series hardware.** Uchida, K.; Sakamoto, K. (National Aerospace Lab., Chofu, Tokyo (Japan)). Nov 1985. vp. (NAL-SP—5). NTIS, PC A12/MF A01.

In the field of numerical analysis for fluid dynamics, there are plenty of calculations which deal with a large number of three-dimensional array data. Supercomputers were developed to satisfy the need for faster-speed scientific and engineering computation, mainly using the pipeline processing method. A supercomputer must achieve not only maximum performance but also effective performance. The parallel execution of instructions is important to increase effective performance. The FACOM-VP provides a number of instruction execution pipelines and a control method that makes these pipelines proceed effectively to achieve parallel processing in addition to the pipeline processing method. The technique used in the FACOM-VP to execute a scalar instruction and vector instructions in parallel and also vector instructions in parallel is explained.

20902 **(N—87-14247) Data base system for numerical simulator.** Ishizuka, T.; Miyoshi, H.; Aki, T. (National Aerospace Lab., Chofu, Tokyo (Japan)). Nov 1985. vp. (NAL-SP—5). NTIS, PC A12/MF A01.

The necessity for computer simulation in research and development in aeronautics and astronautics has increased at a rapid pace in recent years. In particular, sophisticated large and fast computers are required to perform simulations at a practical level. The National Aerospace Laboratory of Japan is now promoting a numerical simulator project (NS project), which includes the introduction of a supercomputer. As a part of this project, a data base system was constructed for the purpose of managing input and test data necessary for numerical simulation and allowing many different kinds of utilization. The summary of this data base system and the functions of operational commands employed in the system are explained

from the viewpoint of the user. Firstly, data available in this system are considered. Secondly, ways of creating a data base system that meets the demands of the field of numerical simulation are discussed. Thirdly, major features of the operational commands are explained. Finally, a list of operational commands and examples are presented.

20903 **(N—87-14247) Numerical simulation of transonic flow fields by solving the three-dimensional Navier-Stokes equations.** Fujii, K.; Yoshida, M.; Obayashi, S. (National Aerospace Lab., Chofu, Tokyo (Japan)). Nov 1985. vp. (NAL-SP—5). NTIS, PC A12/MF A01.

The LU-ADI factored scheme was successfully applied to solving the three-dimensional compressible thin-layer Navier-Stokes equations. The computations were performed for the slightly supersonic flow over a hemispheric cylinder at high incidence and for the transonic flow over a swept wing. To simulate these complicated flow fields, fine grid distributions up to about 200,000 points were used on a Japanese supercomputer. The total cpu time for each case was less than two hours. The result for the flow over a hemispheric cylinder at high incidence revealed the existence of the shock wave and the detailed structure of the vortical flow field on the leeward side. The improved version of the LU-ADI scheme was then developed and used for the simulation of the viscous transonic flow fields over the main wing of a practical transportation aircraft. Excellent agreement was obtained between the calculated pressure distribution over the surface and that of the experiment. The three-dimensional complicated separation phenomenon was also revealed for the case of relatively high angle of attack. These results indicate the capability of the present code to simulate three-dimensional complicated flow fields. The application of the present code to more practical flow fields such as transonic flows over a wing-body combination of transportation is very promising. Even simulation over the whole aircraft geometry may soon be possible.

20904 **(N—87-14656) Three-dimensional Euler flow simulation on a Cyber 205 vector computer.** Koppenol, P.J. (National Aerospace Lab., Amsterdam (Netherlands)). Mar 1985. 65p. (NLR-TR—85054-U; B—8669019; ETN—86-98652). NTIS, PC A04/MF A01.

A computational method for solving the three dimensional Euler equations, based on an upwind flux-difference splitting scheme by Osher, exhibiting an implicit mechanism for numerical viscosity, with an explicit time-marching finite volume technique is studied. The computer program runs efficiently on a scalar computer and the Cyber 205 vector computer. Demands made by the necessity of vectorizability of the code, on algorithm, data structuring, and the code itself, are discussed. The large data sets involved appear to impose severe claims on central memory size, I/O devices, and line connections. The method is tested for a transonic and supersonic quasi two dimensional channel flow. The Euler model is found to give an accurate simulation of aerodynamic phenomena in the channel.

20905 **(SAND—86-1403C) Upwind inviscid computations of complex geometries in hypersonic flow.** Noack, R.W. (Sandia National Labs., Albuquerque, NM (USA)). Jan 1987. Contract AC04-76DP00789. 16p. (AIAA—87-0281; CONF-870133—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004520.

From 25. AIAA aerospace sciences meeting; Reno, NV, USA (12 Jan 1987).

A new flux vector splitting approach is presented for the solution of three-dimensional, steady, inviscid, supersonic, flows with embedded strong shocks and crossflow. The present formulation splits the equations based on the eigenvalues in the space-time planes which are normally used to split the unsteady equations. The flux vector splitting methods of Steger-Warming and Van Leer which were developed for the solution of the unsteady equations are tested for the solution of the steady space marching equations. In addition, a method is presented to reduce the geometrically induced errors of the transformed conservative finite difference formulation. The present formulation is tested on a hemispherically blunted cone, sphere-cone-flare, and a sphere-bicone with drag flaps. The surface pressure on the flap is compared with experimental data.

20906 **(SAND—86-2960C) A spatial marching technique for the inviscid blunt body problem.** Davis, R.T.; Blottner, F.G. (Sandia National Labs., Albuquerque, NM (USA); Cincinnati Univ., OH (USA). Dept. of Aerospace Engineering and Engineering Mechanics). 1987. Contract AC04-76DP00789. 12p. (CONF-870473—1). NTIS, PC A02. File Number DE87004526.

From AGARD fluid dynamics panel symposium; Bristol, UK (6 Apr 1987).

A technique has been developed for obtaining approximate solutions of the inviscid, hypersonic flow on a blunt body with a spatial marching scheme. The scheme introduces the Vigneron pressure gradient approximation into the momentum equation in the direction along the body surface. The resulting governing equations are hyperbolic. With a specified shock wave these equations are solved at the stagnation streamline with an iteration procedure and are solved in the downstream direction with a marching scheme. The complete Euler equations are solved with the numerical scheme when the flow is supersonic. A global iteration procedure is required to obtain the shock wave location. The approximate results from the spatial marching technique are compared with the complete solution of the Euler equations for flow over a sphere. The two results are shown to be in approximate agreement and the spatial marching technique provides useful engineering predictions while requiring considerable less computational time.

20907 **(UCLA-ENG-P—5566-C-86) Enhancement of critical heat flux in tubes using staged tangential flow injection: [Progress report].** Dhir, V.K. (California Univ., Los Angeles (USA). Dept. of Mechanical, Aerospace and Nuclear Engineering). 1987. Contract FG03-85ER13360. 13p. NTIS, PC A02. File Number DE87004589.

Experimental studies of the enhancement in single and two phase heat transfer from tubes subjected to tangential flow injection have been continuing. Investigations using water as the test liquid have been focused on: single phase heat transfer coefficients; two phase heat transfer coefficients under subcooled boiling conditions; subcooled critical heat fluxes; and modeling of the enhancement under swirl flow conditions. With tangential injection up to four fold increase in the average heat transfer coefficient has been observed. During subcooled boiling the enhancement is relatively small. However swirl induced centripetal force increases vapor escape velocity and as a result higher critical heat fluxes can be accommodated. In the range of flow parameters studied up to 40% enhancement in critical heat flux has been observed with single stage injection. This enhancement is slightly less than that obtained with Freon-113. The mechanistic reasons for this observation are currently being investigated.

20908 **Shock loading a rippled interface between liquids of different densities.** Benjamin, R.F.; Fritz, J.N. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physics of Fluids;* **30**: No. 2, 331-336(Feb 1987).

Experimental results of the nonlinear growth of perturbations on a shocked interface between liquids having a density ratio of 10 are reported. After the shock passes from the higher-density liquid into the lower-density liquid, spikes of the higher-density liquid are observed to grow into the other liquid without producing severe turbulence. The measured growth is compared with analytical estimates. The time-resolved shadowgraphs provide excellent data for testing hydrodynamics models.

20909 **Heat transfer effects of a longitudinal vortex embedded in a turbulent boundary layer.** Eibeck, P.A.; Eaton, J.K. (Assistant Professor, Department of Mechanical Engineering, University of California: Berkeley, Berkeley, California). *Journal of Heat Transfer;* **109**: No. 1, 16-24(Feb 1987).

The heat transfer effects of an isolated longitudinal vortex embedded in a turbulent boundary layer were examined experimentally for vortex circulations ranging from $\Gamma/U/sub\ \infty/\delta_{99} = 0.12$ to 0.86. The test facility consisted of a two-dimensional boundary layer wind tunnel, with a vortex introduced into the flow by a half-delta wing protruding from the surface. In all cases, the vortex size was of the same order as the boundary-layer thickness. Heat trans-

fer measurements were made using a constant-heat-flux surface with 160 embedded thermocouples to provide high resolution of the surface-temperature distribution. Three-component mean-velocity measurements were made using a four-hole pressure probe. Spanwise profiles of the Stanton number showed local increases as large as 24 percent and decreases of approximately 14 percent. The perturbation to the Stanton number was persistent to the end of the test section, a length of over 100 initial boundary-layer thicknesses. The weakest vortices examined showed smaller heat transfer effects, but the Stanton number profiles were nearly identical for the three cases with circulation greater than $\Gamma/U/\text{sub } \infty/\delta_{99} = 0.53$ cm. The local increase in the Stanton number is attributed to a thinning of the boundary layer on the downwash side of the vortex.

20910 **Convection calibration method for local heat flux gages.** Borell, G.J.; Diller, T.E. (Harris Corporation, GASD, Melbourne, FL 32902). *Journal of Heat Transfer;* **109**: No. 1, 83-89(Feb 1987).

An apparatus for calibrating local heat flux gages in convective air flows is described. Heat transfer from a "hot" gage to a "cold" fluid was measured using a guarded hot-plate technique. The system was used to calibrate Gardon-type circular foil heat flux gates of 1/8 in. and 1/16 in. outer diameters. The reslts indicate that the calibration curves are nonlinear, which is different from the linear calibration obtained using the standard radiation technique. The degree of nonlinearity matches the analysis which accounts for the effect of the temperature distribution in the gage foil. The effect of this temperature distribution can be neglected in the standard radiation calibration but is often significant in convection applications. These results emphasize the importance of calibrating heat flux gates in thermal environments similar to those in which they will be used.

20911 **Criteria for the onset of flow recirculation and onset of mixed convection in vertical rod bundles.** Symolon, P.D.; Todreas, N.E.; Rohsenow, W.M. (General Electric Company, Schenectady, NY 12301). *Journal of Heat Transfer;* **109**: No. 1, 138-145(Feb 1987).

In a vertical rod bundle with forced upflow and a nonuniform radial power profile, the potential for flow reversal into the low power side of the bundle exists due to buoyancy forces. In this paper a criterion is developed to predict the onset of flow recirculation in rod bundles. The criterion is validated with experimental data for flow recirculation in water-cooled bare rod bundles and with the results of a standard multichannel rod bundle code. A criterion for the onset of mixed convection is also given. Thus, the boundaries between the forced convection, mixed convection, and recirculation regimes are identified. Results are expressed on a flow regime map in terms of the dominant dimensionless parameters (the Reynolds number and a buoyancy parameter $B^*$) as a closed-form equation.

20912 **Determination of the optimum gas velocity for dilute phase transport of coarse particles in large vertical tubes.** Zhang, J.Y.; Yang, G.L. (Institute of Coal Chemistry, Academia Sinica, US Dept. of Energy, Pittsburgh Energy Technology Center, P.O. Box 10940, Pittsburgh, PA). pp 221-228 of Circulating fluidized bed technology. Basu, P. Elmsford, NY; Pergamon Books Inc. (1986). (CONF-851127—).

From 1. international conference on circulating fluidized beds; Halifax, Nova Scotia, Canada (18 Nov 1985).

A series of experiments was conducted concerning vertical dilute-phase transport in large-diameter tubes at high temperatures. The data obtained in these experiments were used to develop an empirical method for estimating the optimum gas velocity (U/sub op/) for vertical dilute-phase transport in large tubes and empirical equations for scale-up to larger tubes.

20913 **Heat transfer analyses of liquid heated boiling fluids with attention to transition boiling.** Shin, S.K. Chicago, IL; Univ. of Illinois (1986). 265p. University Microfilms Order No. 86-11,308.

Thesis (Ph. D.).

Four major methods of analysis were developed for the turbulent flow of a liquid metal in an annulus under a thermally developing condition with arbitrary axial wall temperature distribution. The methods were applied to measurements made in two large scale test facilities, at Argonne National Laboratory and Westinghouse Electric Corp., where water boiling inside of a tube was the forcing function for heat transfer in a surrounding sodium annulus. The primary application of the methods is in the area of reduction of experimental data from liquid metal heated steam generator tests. The tests considered covered a range of water parameters of 400-2500 kg/m²s mass flux and 6.9-15.6 MPa pressure. Results from the four methods (and modifications of them) were compared on a quantitative basis for calculated parameters of heat flux, wall temperature, water temperature, quality and heat transfer coefficient. The region of highest thermal gradients was investigated in an ancillary study of transition boiling heat transfer under sodium-heated conditions. Models were developed for the inclusion of transition boiling heat transfer in the overall thermal analysis of liquid heated, boiling water heat exchangers. Two empirical relations, developed from extensive available data, were key features in the application of these models.

## 4205 Materials Testing

*REFER ALSO TO CITATION(S) 20389, 20403, 20530, 20588, 20589, 20664, 20699, 20844, 21717, 21718*

20914 **(CEA-CONF—8561) Automatic analysis of ultrasonic data.** Horteur, P.; Colin, J.; Benoist, P.; Bonis, M.; Paradis, L. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Oct 1986. 7p. (In French). (CONF-8609218—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751023.

From 6. international conference on non destructive testing methods; Biarritz, France (30 Sep 1986).

This paper describes an automatic and self-contained data processing system, transportable on site, able to perform images such as "A. Scan", "B. Scan", ... to present very quickly the results of the control. It can be used in the case of pressure vessel inspection.

20915 **(CEA-CONF—8582) Automatic appraisal of defects in irradiated pins by eddy current testing.** Marsol, R.; Cornu, B.; Gaillard, P. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Oct 1986. 8p. (In French). (CONF-8609218—2). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751041.

From 6. international conference on non destructive testing methods; Biarritz, France (30 Sep 1986).

Eddy current testing is very efficient to inspect the sheaths of spent fuel elements. Automation of the process is developed to replace visual examination of recorded eddy current signals. The method is applied to austenitic steel fuel cans for fast neutron reactors to detect cracks, voids, inclusions. The different types of defects and experimental processes are recalled then automatic detection and the method for defect qualification are presented.

20916 **(CONF-861207—78) Characterizing the hardness and modulus of thin films using a mechanical properties microprobe.** Oliver, W.C.; McHargue, C.J. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006612.

From Materials Research Society fall meeting; Boston, MA, USA (1 Dec 1986).

A new ultra-low load microindentation system has been acquired in the Metals and Ceramics Division of ORNL. The system's spacial resolution and its data acquisition capabilities allow the determination of several mechanical properties from submicron volumes of materials; hence, the term mechanical properties microprobe (MPM). In this paper we demonstrate the ability of such a system to measure the modulus and hardness of an ion implanted sapphire specimen. The implantation process results in an amorphous surface layer 155 nm thick. The hardness and modulus of the

amorphous $Al_2O^3$ are 10 and 200 GPa, respectively. This represents a 60% reduction in hardness and a 50% reduction in modulus as compared to the unimplanted material.

20917 **(EGG-M—32586) Determination of crack initiation sites using a digital NDE workstation.** Barna, B.A.; Johnson, J.A.; Allemeier, R.T. (EG and G Idaho, Inc., Idaho Falls (USA)). Nov 1986. Contract AC07-76ID01570. 6p. (CONF-8611110—2). NTIS, PC A02/MF A01. File Number DE87001444.

From SEM fall meeting; Keystone, CO, USA (2 Nov 1986).

A digital acoustic emission data acquisition and analysis system has been configured to dynamically follow and record the acoustic emissions generated by individual crack initiation sites during fracture. The purpose of this research is to analyze the dynamics of the growing fracture and to discriminate between fracture mechanisms through pattern analysis of the received signals. The work described in this paper is the preliminary experiments using a laser as a simulated AE source for calibration and two experiments in which data were collected from a three-point-bend titanium fracture test.

20918 **(FhG-W—1/85) Experimental investigations on dynamic effects in impact notch bending tests.** Boehme, W. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Freiburg im Breisgau (Germany, F.R.). Inst. fuer Werkstoffmechanik; Technische Hochschule Darmstadt (Germany, F.R.). Fachbereich 6 - Mechanik). Jun 1985. 136p. (In German). NTIS (US Sales Only), PC A07/MF A01. File Number DE87751264.

The dynamic behaviour of three point bending samples under impact stresses is examined experimentally. Various measuring processes, above all the shadow optics etching process are used. A quasi-static analysis is made by a simple spring/mass model to describe the stress behaviour quantitatively. Based on this, the dynamic effects in model experiments are measured quantitatively with dynamic correction functions and are discussed with reference to the wave processes in the sample. A systematic view of the effect of the many system parameters on the dynamic stress behaviour is obtained. Finally, examples show that the results of this model investigation can be transferred to other experimental conditions. With 55 figs., 5 tabs., 75 refs.

20919 **(FhG-W—7/85) Possible uses and limits of probability models in connection with the reliability of large scale plants. Final report.** Baudendistel, E.; Schmitt, W. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Freiburg im Breisgau (Germany, F.R.). Inst. fuer Werkstoffmechanik). Aug 1985. 80p. (In German). NTIS (US Sales Only), PC A05/MF A01. File Number DE87751265.

The existing probability models and failure theories were compiled and discussed, where the main point was a study of previous literature on brittle and ductile fracture. In order to describe ductile failure, analytical models of growth of isolated hollow spaces were developed, when looking at the formation of microcracks and later failure. Due to the observed pore formation with great plastic deformation, material laws were developed, which started from the assumption of incompressible plastic deformation. From taking into account the phenomenon of formation, growth and combination of hollow spaces by suitable material laws, it was found that one has to start from a non-homogeneous distribution of the hollow spaces, which can lead to unstable plastic deformation in the form of shear strips between large hollow spaces in the material. Numerical methods (e.g. FEM) were used in the development and testing of the models. In describing brittle fracture, models based on the work of Weibull and the model of the weakest member are used, which were expanded by various modifications. With 16 figs., 70 refs.

20920 **(IAEA-R—3227-F) Development of a nondestructive testing method and facility for investigation of surface reactions appearing in damage, corrosion, adsorption and catalytic processes encountered in the heat transfer systems of nuclear power plants and the energy storage problems. Final report for the period 1 August 1982-31 July 1986.** (International Atomic Energy Agency, Vienna (Austria)). Aug 1986. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700884.

Studies of corrosion, oxide layer growth, etc., necessitate the investigation of processes which take place at surfaces: adsorption and desorption. Two problems are of major importance: I) initial stages of oxidative attack, e.g. the adsorptive properties of oxygen for a given system and possible synergetic effects of coadsorbed species like CO, H/sub 2/O, OH, H/sub 2/, SH/sub 2/, impurities, and II) the influence of surface conditions (crystalography, defects, pores, impurities, segregates) on the oxidative attack. An apparatus has been developed with three surface sensitive techniques: a) quartzcrystal micro-balance as a method for measuring the kinetics of deposition of thin metal films and gas adsorption, b) diode probe for the measurement of work function change caused by gas adsorption at metallic surfaces, and c) thermal desorption spectroscopy (TDS) which gives information on adsorption/desorption properties of a system studied: activation energy, preexponential factors for desorption, coverage, precursor states, lateral interaction, etc. The system investigated was oxygen/palladium foil (polycrystalline) by means of TDS and the following conclusions have been drawn: 1. Oxygen adsorbs on Pd foil both dissociatively and nondissociatively - depending on the adsorption temperature. 2. Certain amounts of oxygen penetrates into the surface and subsurface region, giving rise to a desorption peak around 1350K. 3. There are two groups of desorption peaks corresponding to atomically adsorbed oxygen (730K and 800K). The analysis of these peaks show the existence of strong lateral interactions between oxygen atoms at high coverages, which is not the case for low coverages. The position of the peaks and the dynamics of their evolution is consistent with the data obtained for Pd(111) and Pd(100) single crystal surfaces. 8 refs, 3 figs.

20921 **(Y/CSD/INF—86/28) Acoustic emission point source locations on thin spherical shell.** Burenko, O.; Whittaker, J. (Oak Ridge Y-12 Plant, TN (USA)). Jan 1987. Contract AC05-84OS21400. 10p. (CONF-870478—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004015.

From Southeastcon '87; Tampa, FL, USA (5 Apr 1987).

A point source of acoustic emission on a thin spherical shell is defined in spherical and Cartesian coordinates. A required number of acoustic sensors and their locations are postulated for a unique determination of an acoustic emission point source location. Spherical coordinates of an acoustic emission point source are computed using acoustic sensors' measured channel time-differences, radius, and sound propagation velocity in a thin spherical shell.

20922 **Analysis of solid surfaces using a pulsed-laser time-of-flight atom-probe.** Tsong, T.T.; Liu, Y.; McLane, S.B. (Pennsylvania State University, University Park, PA 16802). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 732-733(15 Aug 1986). (CONF-851185—).

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

A high resolution pulsed-laser time-of-flight atom-probe field ion microscope has been developed which is a surface analytical tool of single atom detection sensitivity. It is a mass and energy analyzer with a resolution and accuracy of —5 parts in $10^5$, and an ion reaction time measuring device of 20 fs time resolution. This system can be used to analyze surface atoms one by one and surface atomic layers one by one also. The application of this system to study solid surfaces are described.

20923 **Thermal wave studies of coatings and coated materials.** Koo, P.K.; Favro, L.P.; Reyes, C.B.; Thomas, R.L. (Wayne State Univ., Detroit, MI). pp 1519-1523 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This paper presents a theoretical expression which describes the mirage effect signal from a multi-layer system. Preliminary computations using this expression are plotted and compared with experimental results on model systems.

20924 **Commercialization of technology: considerations for successful transfer.** Posakony, G.J. (Buttelle Pacific Northwest Labs., Richland, WA). pp 1735-1738 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

The author interviewed a number of organizations that are in the business of analyzing breakthrough technology to determine if commercialization of the technology could be profitable for their company. Fundamental factors that are taken into consideration include: market analysis, business plan, people and incentives, investment and risk, technology of the receiving organization, and promotion to gain acceptance.

20925 **University efforts in the technology transfer process.** Thompson, R.B. (Ames Lab., Iowa State Univ., Ames, IA). pp 1743-1747 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

A conceptual sketch is presented of the two culture syndrome and its implication on NDE technology transfer. Categories of courses required in NDE curricula are discussed and the concept of industrial/university cooperative research centers are shown. The university's role in the technology transfer process is defined by its basic missions of creation of knowledge and dissemination of this knowledge through the education of people. Industrial-University Centers can play a key role in bridging the (illegible) cul (illegible) gap, which impedes the technology transfer process, through the joint formulation and execution of research projects and the education of students to carry out these activities.

20926 **Nde technology transfer within the U.S. DOE weapons complex.** Willis, A.R. (Sandia National Labs., Livermore, CA). pp 1755-1759 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

This paper discusses the attributes and the operation of the weapons complex which contribute to the successful transfer of nondestructive evaluation (NDE), as well as other technologies, from research and development (R&D) status to production applications. Examples of NDE technology transfer are also presented. The paper presents the attributes of the DOE weapons complax that contribute to effective NDE technology transfer from R&D organizations to production applications.

20927 **Transition and transfer of technology - panel session discussions: a summary.** Posakony, G.J. (Battelle, Pacific Northwest Lab., Richland, WA). pp 1761-1767 of Quantitative nondestructive evaluation: Vol. 5B. Thompson, D.O.; Chimenti, D.E. New York, NY; Plenum Press (1986). (CONF-8506110—).

From Review of progress in quantitative NDE; Williamsburg, VA, USA (23 Jun 1985).

A number of "action items and descriptors" were identified. Selected topics which identify areas that might be of particular concern to readers are presented. The topical descriptors listed by the group are divided into the following categories: education, industry/industry interaction, match technology with needs, enhance the image of NDE, develop incentives for technology transfer, and identify issues which inhibit technology transfer.

## 4208 Electronic Circuits And Devices

20928 **(EPRI-EA—4985) The Transformer/Capacitor Risk Management model: Final report.** Boyd, D.W.; Cohan, D.; Wilson, D.S. (Decision Focus, Inc., Los Altos, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Jan 1987. 129p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920236.

This report describes the Transformer/Capacitor Risk Management (TRIM) model. TRIM is an integrated risk management tool, based on the methodology of decision analysis, that can be used to analyze the costs and benefits of alternative regulatory policies and utility actions involving electrical equipment containing PCBs. TRIM consists of a decision tree, representing the interactions of decision alternatives with critical uncertainties, and a deterministic model, which traces the potential impact of PCBs from their use in electrical equipment, through release due to spills or accidents and resulting human and environmental exposure, to any ensuing health or environmental effects. The TRIM software is described in a set of user notes.

20929 **(HEDL-SA—3577-FP) An operational amplifier laboratory employing SPICE analysis technique.** Carlisle, B.S. (Hanford Engineering Development Lab., Richland, WA (USA); Tri-Cities Univ. Center, Richland, WA (USA)). Aug 1986. Contract AC06-76FF02170. 7p. (CONF-8611132—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005462.

From WESCON '86; Anaheim, CA, USA (18 Nov 1986).

Computer based models for integrated circuit operational amplifiers were developed to permit compensation circuit analysis. A laboratory course based on these models was also developed to complement a senior level course in Operational Amplifiers. The student response to the course verified the value of the model as an educational tool and the analysis results indicate that the models may also prove to be a valuable tool for design engineers. Though specifically developed for this course, the model and computer based techniques discussed may be employed in additional labs supporting courses in control principles and linear circuit design.

20930 **(UCRL—95276) Silicon pulse sharpening diodes: Switching kilovolts in 10's of picoseconds.** Pocha, M.D.; Wiedwald, J.D.; Dease, C.G.; Contreras, M.M. (Lawrence Livermore National Lab., CA (USA); New Mexico Univ., Albuquerque (USA)). Jan 1987. Contract W-7405-ENG-48. 6p. (CONF-870114—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005073.

From IEEE/OSA topical meeting on picosecond electronics and optoelectronics; Lake Tahoe, NV, USA (14 Jan 1987).

Numerical analysis was used to determine the physical mechanisms involved in silicon switching diodes. Plots of values for free carrier densities, current density, electric field, etc. were used in visualizing the operation of these devices. It is concluded that the large initial electric field present in the diode is responsible for its behavior. (JDH)

20931 **(UCRL—95475) Magnitude and phase calibration of microwave sensors.** McLeod, R.R.; Hudson, H.G.; King, R.J. (Lawrence Livermore National Lab., CA (USA)). Dec 1986. Contract W-7405-ENG-48. 16p. (CONF-860198—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003466.

From National radio science meeting; Boulder, CO, USA (12 Jan 1986).

Current network analyzer technology allows both magnitude and phase to be accurately recorded in antenna measurements, raising the possibility of fully characterizing microwave sensors. These calibrated sensors can then take data which may be convolved with arbitrary inputs as well as transformed into the time domain. Such measurements require, however, some standard calibration to measure against: a "standard phase horn" so to speak. This paper first

extends the definitions of several commonplace antenna parameters and equations to include phase. Given these necessary tools, a number of methods are used to derive a phase calibration and the results are presented. While every method used yields the proper results, only a few are easily applicable to phase measurements. Using these results, a calibration curve is derived for the Lawrence Livermore National Laboratory EMPEROR monocone. Comparison with low-frequency D probes shows the calibration to be accurate to within 1 dB and 5 degrees. EMPEROR is then found to be a nearly perfect, "flat" transmitter from 50 Mhz to 18 GHz. This allows it to be used as magnitude and phase calibration range. In concert with an HP 8510 based measurement system, this allows engineers to quickly and accurately measure the complete response of antennas and other EM systems.

20932 **Studies of microwave radiation from a low-energy rotating electron beam in a multiresonator magnetron cavity.** Chojnacki, E.; Destler, W.W.; Lawson, W.; Namkung, W. (Electrical Engineering Department, University of Maryland, College Park, Maryland 20742). *Journal of Applied Physics;* **61**: No. 4, 1268-1275(15 Feb 1987).

The generation of microwave radiation at high harmonics of the cyclotron frequency by a low-energy annular rotating electron beam (27 kV, 1 A, 3 $\mu$s) via interaction with the modes of a magnetron-type conducting boundary has been studied experimentally. Details of producing the axis-encircling E layer by magnetic cusp injection are presented. Narrow-band microwave radiation has been obtained from the device at power levels of 9.1 kW at 6.78 GHz (eighth cyclotron harmonic) and 2.2 kW at 8.85 GHz (tenth cyclotron harmonic). Measurements of the radiated power spectra and confining magnetic field have allowed identification of operating waveguide modes and instability mechanisms. An experimental comparison with respect to threshold beam power is presented between waveguide structures operating in the $\pi$ mode and the $2\pi$ mode.

20933 **Phase comparator apparatus and method.** Coffield, F.E. (to Dept. of Energy, Washington, DC). US Patent 4,641,087. 3 Feb 1987. Filed date 1 Feb 1985. vp.

A phase comparator is described for measuring the relative phase difference between first and second electrical signals, the phase comparator comprising: a first channel phase comparator means for producing a lengthened phase difference output representing a greater than actual phase difference between the first and second signal; a second channel phase comparator means for producing a shortened phase difference output representing a less than actual phase difference between the first and second signals; and combining means connected to receive the lengthened phase difference output and the shortened phase difference output and to produce an average thereof as a composite output representing the actual phase difference between the first and second signals.

20934 **Bias-dependent photoresponse of $p^+$ in GaAs/AlAs/GaAs diodes.** Melloch, M.R.; McMahon, C.P.; Lundstrom, M.S.; Cooper J.A. Jr.; Qian, Q.; Bandyopadhyay, S. (School of Electrical Engineering, Purdue University, West Lafayette, Indiana 47907). *Applied Physics Letters;* **50**: No. 3, 161-163(19 Jan 1987).

We report photocollection efficiency measurements of $p^+$ in GaAs/AlAs/GaAs diodes fabricated on films grown by molecular beam epitaxy. Both the zero-bias and bias-dependent photocollection characteristics can be explained by assuming that the band discontinuity between AlAs and GaAs is mostly accommodated in the valence band.

## 4209 Waste Processing Plants And Equipment

20935 **(HEDL—7573) Advanced fluid bed calciner information on IR-100 award.** Druby, M.C.; Owen, T.J.; Klem, M.J. (Hanford Engineering Development Lab., Richland, WA (USA)). Jan 1986. Contract AC06-76FF02170. 10p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005489.

The advanced fluidized bed calciner provides time, temperature and turbulence to change a liquid slurry such as ammonium diuranate into a uranium dioxide powder. The liquid is sprayed into a hot chamber (up to 700°C) which includes thousands of tiny metal beads, about the size of BB's. The constantly moving beads provide an efficient heat transfer media for the immediate transformation of the slurry droplets into dry particles of powder, which are carried out by hot nitrogen gas and recovered in a collector.

## 4210 Combustion Systems

*REFER ALSO TO CITATION(S) 20898, 20899*

20936 **(N—87-13486) Enhanced heat transfer combustor technology, subtasks 1 and 2, test C.1. Interim report.** Baily, R.D. (Rockwell International Corp., Canoga Park, CA (USA)). Dec 1986. 305p. (NASA-CR—179541; NAS—1.26:179541; RI/RD—86-199). NTIS, PC A14/MF A01.

Analytical and experimental studies are being conducted for NASA to evaluate means of increasing the heat extraction capability and service life of a liquid rocket combustor. This effort is being conducted in conjunction with other tasks to develop technologies for an advanced, expander cycle, oxygen/hydrogen engine planned for upper stage propulsion applications. Increased heat extraction, needed to raise available turbine drive energy for higher chamber pressure, is derived from combustion chamber hot gas wall ribs that increase the heat transfer surface area. Life improvement is obtained through channel designs that enhance cooling and maintain the wall temperature at an accepatable level. Laboratory test programs were conducted to evaluate the heat transfer characteristics of hot gas rib and coolant channel geometries selected through an analytical screening process. Detailed velocity profile maps, previously unavailable for rib and channel geometries, were obtained for the candidate designs using a cold flow laser velocimeter facility. Boundary layer behavior and heat transfer characteristics were determined from the velocity maps. Rib results were substantiated by hot air calorimeter testing. The flow data were analytically scaled to hot fire conditions and the results used to select two rib and three enhanced coolant channel configurations for further evaluation.

20937 **(N—87-14424) Dual-throat thruster thermal model. Final report.** Ewen, R.L.; Obrien, C.J.; Matthews, L.W. (Aerojet Techsystems Co., Sacramento, CA (USA)). Aug 1986. 465p. (NASA-CR—178975; NAS—1.26:178975; REPT—34136F; REPT—BB0216). NTIS, PC A20/MF A01.

The dual-throat engine is one of the dual nozzle engine concepts studied for advanced space transportation applications. It provides a thrust change and an in-flight area ratio change through the use of two concentric combustors with their throats arranged in series. Test results are presented for a dual throat thruster burning gaseous oxygen and hydrogen at primary (inner) chamber pressures from 380 to 680 psia. Heat flux profiles were obtained from calorimetric cooling channels in the inner nozzle, outer or secondary chamber and the tip of the inner nozzle. Data were obtained for two nozzle spacings over a chamber pressure ratio (secondary/primary) range of 0.45 to 0.83 with both chambers firing (Mode I). Fluxes near the end of the inner nozzle were significantly higher than in Mode II when only the inner chamber was fired, due to the flow separation and recirculation caused by the back pressure imposed by the secondary chamber. As the pressure ratio increased, these heat fluxes increased and the region of high heat flux relative to Mode II extended farther upstream. The use of the gaseous hydrogen bleed flow in the secondary chamber to control heat fluxes in the primary plume attachment region was investigated in Mode II testing. A thermal model of a dual throat thruster was developed and upgraded using the experimental data.

20938 **(ONERA-RTS—7/7104-EY) Measurement of pressure fluctuations on the wall of a turbulent combustion furnace. Final report.** Moreau, P. (Office National d'Etudes et de Recherches Aerospatiales (ONERA), 75 - Paris (France)). Dec 1985. 48p. (In French). (ETN—87-98578). NTIS, PC A03/MF A01.

Data on a furnace were obtained to allow an acoustic analysis. The experimental set-up includes a furnace measuring 100 x 100

x 1328 mm, a main air-methane injector, and a secondary hot gas flow to initiate and to stabilize the combustion. The main flow is characterized by 55 m/sec velocity and a fuel to air ratio adjustable from 0 to 1.2. The results show the presence of almost plane waves. Low frequency fluctuations are found to be stronger in combustion conditions. Other instabilities are also discussed.

### 4220 Underground Engineering

**20939 (AD-A—175224/5/XAB) Shock and Vibration Bulletin. Part 1. Welcome, invited papers, shipboard shock, blast and ground shock, shock testing, and analysis.** (Naval Research Lab., Washington, DC (USA). Shock and Vibration Information Center). Aug 1986. 202p. (BULL—56-PT-1). NTIS, PC A10/MF A01.

See also Part 2, AD-A175 225.

Partial contents include: Solid Mechanics Program at ONR; Army research in shock mechanics; Air Force basic research in dynamics and control of large space structures; State-of the art assessment of structural dynamic response analysis methods (DYNAS); DYNAS survey - Part 2 -- A participant view; Computation of excitation forces using structural response data; Underwater shock trials on a plain, unreinforced cylinder; Investigation into the effects of using detonating cord to remove a conventional propeller from a water borne surface ship; Dynamic response of armor plate to nonpenetrating projectile impact; Evaluation of shock response in combat vehicles -- Scale model results; Yield effects on the response of a buried blast shelter; Shelter response in a simulated one megaton nuclear event; Vibration characteristics of a large scale buried structure; A numerical gauge for structural assessment; Active one-dimensional protective layers; Dependence of free-field impulse on the decay time of energy efflux for a jet flow; Computer implementation of a muzzle blast prediction technique; and Interim design criteria and acceptance test specifications for blast-resistant windows.

### 4250 Power Cycles

*REFER ALSO TO CITATION(S) 20247*

## 43 PARTICLE ACCELERATORS

**20940 (GANIL-RA—1985) 1985. GANIL progress report.** (Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France)). 1986. 48p. (In French). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751055.

The accelerator and auxiliary equipment are presented. Last results are explained and commentated. Non-nuclear activities at CIRIL laboratory, on the site, are also presented. They are concerned with atomic physics, condensed matter and biology.

### 4301 Design, Development, And Operation

*REFER ALSO TO CITATION(S) 22017*

**20941 (CEA-CONF—8528) New electron linac for the Saclay stretcher ring project.** Aune, B.; Bourat, C.; Djidi, K.; Jablonka, M.; Juillard, M.; Netter, F. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Jun 1986. 3p. (CONF-860629—65). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751008.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The ALS-II project is an electron accelerator designed for a maximum energy of 1.7 GeV and nearly 100% duty cycle. It consists in a low duty factor linac injecting a pulse stretcher ring. The existing linac (0.6 GeV, 1% duty cycle) has to be transformed in keeping the same accelerating sections. It will use 23 new klystrons (25 MW, 25 KW, efficiency approximately 60%) now under development by Thomson-CSF. In addition the beam will be bunched at 600 MHz ($f_0/5$), to match the RF frequency of the ring. A subharmonic prebunching system, including a 600 MHz chopper is described.

**20942 (INIS-SU—378, pp 8-12) Direct neutrino beams from high-energy electron accelerators.** Saleev, V.A.; Tsarev, V.A. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780101.

Kratkie Soobshcheniya po Fizike.; No. 2.

In Experimental and theoretical physics. Collection.

In the present paper the possibility of obtaining "direct" neutrinos in the linear accelerator operating directly in the electron acceleration mode is evaluated. High-energy linear electron accelerators under the condition of attaining in them high acceleration rate can be used as well for acceleration of pions. This provides the possibility for obtaining intense narrow neutrino beams which can be used in fundamental and applied investigations. The spectrum of "direct" neutrinos from photoproduction and decay of charmed particles is calculated and the flow of accompanying muons is found.

**20943 (INS—562) Report on ICFA.** (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study). Nov 1985. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700932.

A general review is made on the ICFA (International Committee for Future Accelerators). It is a sub-committee of the IUPAP (International Union of Pure and Applied Physics)-Commission on Particles and Fields. The origin of ICFA stemmed from series of East-West meetings of senior or leading physists among various regions to review future perspectives in high energy physics and to promote international collaborations. It was established in 1977 and already held twelve meetings in the past. Presently, following four ICFA panels are established: Panel I; Super Conducting Magnets and Cryogenics: Panel II; Beam Dynamics: Panel III; New Accelerator Schemes: Panel IV; Instrumentation. The lists of panel members are given in this report. According to the new guidelines, the construction of VBA (Very Big Accelerator Complex) could be the project in the next century. With respect to international collaborations, the ICFA activities are compared with other fields of big sciences such as space research and fusion project. It is emphasized that in high energy physics, we have the best freedom in performing international collaboration among all sciences. (Aoki, K.).

**20944 (ITEF—110(1985)) Feasibility study on the project of proton-heavy ion accelerating complex on the base of the ITEP proton synchrotron.** Alekseev, N.N.; Veselov, M.A.; Hol'din, L.L. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 62p. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87700975.

Project of the ITEP proton synchrotron reconstruction is under study. The new complex which permits to accelerate ions from hydrogen up to uranium will be developed. The accelerator reconstruction may be divided into three phases. The first phase does not require construction of new accelerating rings. The second and the third phases include construction of accelerators (usual and superconducting ones), which use the available synchrotron as a booster. After finishing the first phase possibility of proton acceleration up to 9.3 GeV will be preserved; light ions may be accelerated up to 3.4-3.7 GeV/n; energy of the most heavy ions will constitute about 1 GeV/n. Light and medium-energy ions with the energy up to 2.5 GeV/n and heavy atoms of all energies will be extracted into existing transport channels. The main peculiarity of the project is a tendency to acceleration of ions preserving a part of electronic shell. Sources of heavy multicharge ions are under discussion along with the project of the accelerator-injector. New design of the vacuum system is suggested. Problems of necessary RF system improvement are discussed too. Schemes of ion injection and extraction are calculated. 6 refs.; 15 figs.; 11 tabs.

20945 **(LA-UR—86-3916) Application of picosecond $CO_2$ lasers to particle accelerators.** Bigio, I.J.; Kurnit, N.A.; Shimada, T.; Harrison, R.F. (Los Alamos National Lab., NM (USA)). 1987. Contract W-7405-ENG-36. 5p. (CONF-870401—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE87003711.

From OSA/IEEE conference on lasers and electro-optics (CLEO '87); Baltimore, MD, USA (27 Apr 1987).

Various advanced accelerator concepts invoke lasers for the generation of very-high-gradient accelerating fields. We introduce the subject and review the application of picosecond $CO_2$ lasers to one such scheme: laser-driven open microstructures.

## 4302 Beam Dynamics, Field Calculations, And Ion Optics

20946 **(IFVE-OKU—85-53) Experimental study on the coherent transverse beam instability at the IHEP accelerator.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 7p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700898.

The experimental results on studing the influence of the form of azimuthal filling of the orbit on the increments of the excited 10th azimuthal harmonics of the circulating frequency are given. They were obtained with the methods, developed for this purpose at the IHEP accelerator. The dependences of the increments on the number of the accelerated bunches of the identical intensity and that of the increments on the intencities in the bunches at step-by-step filling of the orbit allow one to make estimates of the wall memory time and of uncoupled collective motion of the bunches with different intensities. 9 refs.; 3 figs.

20947 (INIS-SU—384, pp 34-37) **Double resonance in a linear polarized ondulator.** Bogdankevich, L.S.; Gelkhviidze, P.K.; Ivanov, V.S.; Krementsov, S.I.; Rajzer, M.D.; Rukhadze, A.A.; Fedotov, A.V. (AN SSSR, Inst. Obshchej Fiziki). 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780105.

Kratkie Soobshcheniya po Fizike.; No. 6.

In Experimental and theoretical physics. Collection.

Background radiation single mode one-pass gain at the length of approximately 9 mm (Hsub(01) mode) is investigated in linear-polarized resonance ondulator under conditions when the period of beam Larmor electrons rotation in homogeneous longitudinal magnetic field is near the time of electron passage through ondulator spatial period. Hollow relativistic electron beam (REB) 18.5 mm in diameter and 0.15 mm thick emitted by graphite cathode of the "Terek-1" accelerator propagated along the stainless steel waveguide with inner diameter of 35.5 mm arranged inside the magnetic system. Experiments were carried out with electron energy approximately 700 keV, beam current approximately 2 kA and pulse duration approximately 20 ns. Ondulator magnetic system consisted of 10 copper rings with inner diameter of 4 cm, width of 1.5 cm arranged with the period of 3.5 cm. Radiation frequency was determined by supercritical waveguide system and a mode - by rotation and displacements of recieving horn at the aperture of the outlet horn. Radiation intensity was measured with cryogenic semiconductor detectors.

20948 (INIS-SU—385, pp 27-31) **Resonance phasing the phasotron beam.** Vorozhtsov, S.B.; Dmitrievskij, V.P.; Onishchenko, L.M. (Joint Inst. for Nuclear Research, Dubna, USSR. Lab. of Nuclear Problems). 1985. NTIS (US Sales Only), PC A04/MF A01. File Number DE87780104. (N—7-85).

In JINR rapid communications. Collection.

A problem to optimize a phasotron capture of the beam into the acceleration mode is considered. The numerical simulation of the accelerated beam dynamics and the experimental check by the initial operation of the JINR phasotron have revealed the effect of the resonance phasing of ions by a wave-like magnetic field during the first phase oscillation of particles. Making use of the effect allowed us to increase considerably the mean rate of the energy gain and the axial beam focusing in the central zone of the machine. The principle problem of structural separation of acceleration and magnet system elements in the central zone has been solved for phasotron with the spatial variation of the magnetic field. 12 refs.; 4 figs.

20949 (INIS-SU—395, pp 33-41) **Experiments on a prolonged confinement of electron-ion rings.** Kuznetsov, I.V.; Perel'shtejn, Eh.A.; Razuvakin, V.N.; Sumbaev, A.P.; Timokhin, V.A.; Cheremukhin, A.E.; Shirkov, G.D. (Joint Inst. for Nuclear Research, Dubna, USSR. Dept. of New Acceleration Methods). 1986. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780088. (N—16-86).

In JINR rapid communications. Collection.

The principle of operation of the magnetic system for formation and prolonged confinement of compressed electron rings was tested. The system has been constructed on the base of a prototype of an electron-ring collective heavy ion accelerator. The effect of synchrotron radiation on the dynamics of variation of compressed electron rings was investigated. Under real conditions of collective accelerator the synchrotron radiation leads to the increase in the electron ring confinement time at small radii from 10 to 20 ms. It is shown that the ring cross section dimensions in the confinement regime remain constant. The results are presented which point to the ion accumulation in the electron rings and to the stable existence of electron-ion rings during their 40 ms confinement in the potential magnetic trap.

20950 **Topics in the physics of particle accelerators.** Sessler, A.M. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA). pp 337-373 of Techniques and concepts of high-energy physics III. Ferbel, T. New York, NY; Plenum Press (1985). (CONF-8408160—).

From NATO advanced study institute on techniques and concepts of high energy physics; St. Croix, VI, USA (2 Aug 1984).

This paper presents discussions on basic accelerator physics an the state of the art's present limitations. Specific parameters of LEP, HERA, TEV2 and SCL are presented and some extrapolation to the next generation of machines such as the Large Hadron Collider (LHC), Superconducting Super Collider (SSC), and Large Linear Colliders. New acceleration methods are discussed.

20951 **New acceleration methods.** Sessler, A.M. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA). pp 375-400 of Techniques and concepts of high-energy physics, III. Ferbel, T. New York, NY; Plenum Press (1985). (CONF-8408160—).

From NATO advanced study institute on techniques and concepts of high energy physics; St. Croix, VI, USA (2 Aug 1984).

Space chargewell accelerators are discussed and illustrated. Wave accelerators are reviewed and the ionization front accelerator is demonstrated. An electron ring accelerator is presented in its simplest version, and the acceleration of the ring, axially, is shown to be caused by a decreasing magnetic field. The inverse free electron laser accelerator is examined for conversion of electron beam energy to coherent electromagnetic energy. The plasma laser accelerator is also examined.

20952 **$e^+$ e/sub -/ colliders.** Bonvicini, G.; Gutierrez, P.; Pellegrini, C. (Univ. of Michigan, Ann Arbor, MI). pp 401-431 of Techniques and concepts of high-energy physics, III. Ferbel, T. New York, NY; Plenum Press (1985). (CONF-8408160—).

From NATO advanced study institute on techniques and concepts of high energy physics; St. Croix, VI, USA (2 Aug 1984).

The authors review the main properties of $e^+$ e/sub -/ colliders concerning storage rings and linear colliders; the basic physics, beam characteristics, limitations on beam current and density; and their influence on the luminosity. A discussion on the transverse motion of the beam is given, and the effects of synchrotron radiation are described. Beam-beam interactions are reviewed. An example design study is used to discuss the relevant parameters of a machine, specifically, the LEP design. The characteristics of a circular collider are illustrated.

## 4303 Auxiliaries And Components

*REFER ALSO TO CITATION(S) 20814, 20855, 21020*

**20953 (CEA-CONF—8527) Improvement of the electron injection for the ALS electron linac.** Aune, B.; Corveller, P.; Damsin, Ph.; Jablonka, M.; Jolly, J.M.; Juillard, M. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Jun 1986. 4p. (CONF-860629—64). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751007.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A smaller transverse beam emittance has been a long required improvement at the ALS electron linac. The goal has been reached by installing a new electron gun, designing a new transition beam line between the gun and the buncher, and changing the first focusing solenoids to more axially symmetric ones. These transformations resulted in a noticeable reduction of the beam emittance as well as in an improvement of the injector accessibility, monitoring and understanding.

**20954 (EFI—778(5)-85) Experimental setup for measuring the polarization of cumulative protons in the γA->pX reaction.** Avakyan, R.O.; Avakyan, Eh.O.; Avetisyan, R.B. (Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike, Moscow (USSR)). 1985. 11p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700860.

An experimental setup which allowed to measure the polarization of cumulative protons in the γA -> px reaction in the proton energy range of 190-270 MeV at bremsstrahlung γ-quanta maximum energy of 4.5 GeV is described. Polarimeter used for proton spin orientation determination includes carbon scatter 25 mm thick and three multiwire proportional chambers with dimensions 512 x 512 mm for proton scattering angule measurement. 3 refs.; 8 figs.; 2 tabs.

**20955** (IA—1421, pp 200) **Water cooled electron gun focused at 90deg, 270deg.** Avida, R.; Friedman, M. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.

In Research laboratories annual report 1985.

**20956 (IFVE-OEA—85-151) High precession reference RF oscillator for starting frequency tuning of the IHEP booster accelerating system.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 21p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700892.

Submitted to the journal Instrum. Exp. Tech. .

Reference RF oscillator for starting frequency tuning of the IHEP booster accelerating system has been described. Flowsheet, main specifications, and calculation technique of automatic frequency control circuit with the use of frequency-dependent phase pulse detector have been presented. Laboratory investigation of the RF oscillator module have confirmed correlation of all input parameters with the given ones. The oscillator has operated at the IHEP booster during the last year. During this period the device has exhibited itself as a convenient and reliable system. Such devices may be used widely at other accelerators where stable values of initial frequency are necessary along with high spectral signal purity and possibility of returning with low discreteness parameter. In this case the retuning simplicity and possibility of operation in a wide frequency range permit to use with success such devices at heavy ion accelerators, where these parameters are of the greatest importance. 11 refs.; 8 figs.

**20957 (IFVE-OI—85-103) Using secondary radiation of a booster injector during its adjustment and investigation.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700897.

Experimental results on the distribution of radiation fields along the booster injector - linear accelerator with HF-focusing are presented and analysis of secondary radiation parameter connection with accelerator regime is given. A dependence of neutron intensity and of accelerated beam current on the phase of HF fields between two sections of the basic part of accelerator (BPA) is presented. Distributions of residual radioactivity on the surface of vacuum case along the first section of BPA are presented. Experiments show that the use of secondary radiation monitoring system, arising during the accelerator opertion facilitates considerably the adjustment of accelerator. The measurement technique permits not only to control quickly the distribuition of particle losses but to conduct different investigations directed to loss maifestation in order to increase beam current at the injector output. 8 refs.; 6 figs.

**20958 (IFVE-OP—85-52) TV method for measuring proton beam parameters.** Gusak, A.A.; Dubasov, Yu.B.; Kuz'menko, V.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700904.

The operation principle of automized TV measurement system (ATMS) for parameter determination of extracted accelerator proton beams is described. The ATMS consists of television equipment, SUMMA modules, Electronics-60 microcoputer and colour display. The measurement time is 2 ms, the information volume is 1 K of 6-bit words. The results on measuring the proton beam parameters at the IHEP accelerator extracted towards the neutrino channel are presented. The developed ATMS permitting to determine the beam profiles, position of its gravity centre and intensity in the real time scale is easily adapted at installations with computer and SUMMA units and may be used as the devise for input and processing of videoinformation in other branches of science and technology. 7 refs.; 5 figs.

**20959 (IFVE-OP-OEA—85-61) Beam profile measurement system in the extended charged particle transport channel.** Galyaev, N.A.; Davydenko, Yu.P.; Dantsevich, G.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700905.

Beam profile measurement system using a microprocessor with a large number of information channels (above 500) installed in the extended (approximately 400 m) channel of the IHEP proton beam transport into the SPhINX experimental installation is described. 14 multichannel chambers of secondary emission are used as the beam detectors. Preliminary data processing is carried out in the immediate vicinity of detectors. Working program written by the ASSEMBLER requires about 250 ms to read and transform data from 500 information channels. Total volume of the program for collection of data on profiles is 11 kbites. The system fully meets the requirements of the operating control of basic beam parameters and may operate both autonomously and in the computer network. 5 refs.; 6 figs.

**20960 (IFVE-OP-OKU—85-182) Particle beam channels development at the IHEP accelerator.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 15p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700906.

Realization of the presented program on the development of IHEP accelerator high intensive beams will permit to solve some important problems at a new qualitatively level: in particular, to investigate rare lepton and electromagnetic hyperon decays; to study properties of production and decay of mesons and baryons with c-quarks, and to conduct a search of new particles and effects. High

intensity of secondary beams permits to promote investigation of quark gluon matter structure when studying processes with high p and deep inelastic neutrino scattering on nucleons. New potentialities are opened in studying light quark spectroscopy, K-meson physics, $\nu$-oscillation search for and varification of e-$\mu$ universal nature. Both production of polarized proton beam and studying of polarization effects become real. 7 figs.; 3 tabs.

20961 **(ITEF—48(1985)) Computer code for calculation of Alvarez type resonator geometrical parameters.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700970.

A numerical-analytical method for calculation of the Alvarez-type resonator is described. Certain improvements in comparison with the known algorithms, making the convergence of the calculational processes more reliable and giving more exact criteria of their stopping are suggested. Program operation in the mode of synthesis is checked experimentally. The resonator sizes are the following: R=325 mm; r=50 mm, where R is radius of the resonator, r is gap radius, the aperture radius a=9 mm. 9 refs.; 4 figs.

20962 **(JAERI-M—86-005) Output characteristics of 2 MeV, 60 kW, dual beam type electron accelerator of TRCRE, JAERI.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1986. 52p. (In Japanese). NTIS (US Sales Only), PC A04/MF A01. File Number DE87701018.

The output characteristics of the dual beam type electron accelerator installed at Takasaki Radiation Chemistry Research Establishment, JAERI in 1981 are described for the convenience of users. The accelerator has two accelerating tubes, for vertical and horizontal beams. The electron beam is independently generated in either direction by using the high voltage switching system. The output of the accelerator is controllable from 0.5 MeV to 2.0 MeV in the acceleration voltage and from 0.1 mA to 30.0 mA in the beam current. The maximum scanning width is 120 cm for vertical beam and 60 cm for horizontal beam. The beam current density distribution and depth-dose distribution for the vertical beam are mainly described as output characteristics of the accelerator. The surface dose distribution, the air dose rate distribution in horizontal beam irradiation room and the temperature rise in the irradiated material during a electron beam irradiation are also described.

20963 **(JINR—9-86-12) Calibration of monitors used to measure electron rings synchrotron radiation in the adhesator with a temperature source.** (Joint Inst. for Nuclear Research, Dubna (USSR). Dept. of New Acceleration Methods). 1986. 7p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701468.

Methods of measuring integral sensitivity of photodetectors used at heavy ion collective accelerator to determine electron ring current by their synchrotron radiation intensity in infrared spectra region are described. Measurements were carried out at the test bed with thermal radiator imitating synchrotron radiation with spectra maximum in the range from 1 $\mu$m < lambdasub(m) < 3 $\mu$m (the radiator temperature range approximately 1000-2500 deg C). Results of measuring calibration constants of two types of noncooled photodetectors (lead selenide photoresistance and silicon photodiode) are presented, analysis of errors is carried out. 9 refs.

20964 **(JINR—R-10-85-891) Autonomous system for magnetic measurements in CAMAC standard.** (Joint Inst. for Nuclear Research, Dubna (USSR). Dept. of New Acceleration Methods). 1985. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701467.

Submitted to the journal Prib. Sist. Upr. .

The elaborated system can be used for the automatic measurements, for the registration and mapping of the pulse magnetic fields values and field gradients in the physical setups. The fields range - up to 2 Tesla; the relatively measurement accuracy - 5 x 10sup(-4); the field gradient range - 0-100 T/cm x 10sup(/4); the measurement accuracy - 2 x 10sup(-5) T/cm. The system has been run of the base of MIKAM microprocessor system and MIX 2M Hall's magnetometer. Its apparatus and software perform: automatic positioning of the Hall sensors over the channel of the magnetic field set up to 10 mm of length and with a 1 m minimal step; statistical analysis of the measured information; rapid mapping during the field hystogram (or gradient) measurement on the colour TV set; the field cardgram and gradient describing on the selfrecorder; the field value and gradient table stamp. The operator system interaction is done in the dialogue regime. 11 refs.; 2 figs.

20965 **(SLAC-PUB—4141) Incorporation of the KERN ECDS-PC software into a project oriented software environment.** Oren, W.; Pushor, R.; Ruland, R. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Nov 1986. Contract AC03-76SF00515. 4p. (CONF-870379—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004566.

From ASP-ACSM annual spring meeting; Washington, DC, USA (26 Mar 1987).

The Stanford Linear Accelerator Center (SLAC) is in the process of building a new particle collider, the Stanford Linear Collider (SLC). The tunnel which houses the SLC is about 3 km long and contains approximately 1000 magnets. Besides a very precise absolute positioning of these magnets, the alignment of adjacent magnet ends is of particular importance to the success of the whole project. Because of this and the limited time frame, a survey method which was not only reliable and self-checking but also fast had to be developed. Therefore, the concept of MAS (Magnet Alignment System) was developed. This system utilizes the on-line data collection and the rigorous least-squares bundle adjustment of the KERN ECDS-PC system to fulfill these requirements. The ECDS software is embedded in a project tailored software system with modules which take care of: fixture and magnet calibration corrections, the calculation of ideal coordinates and their comparison to measured coordinates, the translation of detected misalignments into the coordinate system of the mechanical adjustments and the control of the adjustments with on-line electronic dial-gauges. This paper gives a brief introduction to the SLC project and some of the survey problems which are unique to this machine. The basic ideas of the KERN ECDS-PC system are explained and a discussion of the practical aspects, such as targeting and set-ups, are given. MAS and its modules are explained in detail.

20966 **(UCRL—91849) A statistical interpretation of the J.C. Martin relationship for breakdown of insulators in vacuum.** DiCapua, M.S.; Shannon, J. (Lawrence Livermore National Lab., CA (USA); Maxwell Labs., Inc., San Diego, CA (USA)). 15 May 1985. Contract W-7405-ENG-48. 23p. (CONF-8506338—1). NTIS, PC A02. File Number DE87006242.

From 5. Institute of Electrical and Electronics Engineers pulsed power conference; Arlington, VA, USA (10 Jun 1985).

We discuss the application of Weibull statistics and the J.C. Martin empirical relationship to estimate the cumulative probability of failure of an electrical insulator stressed in vacuum with submicrosecond electrical pulses. We display experimental data and analyze it with Weibull statistics. We apply our results to the design of a much larger insulator ($\sim 10^4 cm^2$) with a desired (10%)-cumulative probability of failure.

20967 **(UCRL—95845) An overview of the Lawrence Livermore National Laboratory Free Electron Laser Program.** Shay, H.D. (Lawrence Livermore National Lab., CA (USA)). 18 Dec 1986. Contract W-7405-ENG-48. 5p. (CONF-861177—8). NTIS, PC A02. File Number DE87005815.

From 9. international conference on lasers and applications; Orlando, FL, USA (3 Nov 1986).

This paper reviews the status of the LLNL Free Electron Laser Program. Rather than using the output of an rf linac, the electron pulse from an induction linac enters the wiggler magnet without being bunched into small packets. The laser beam makes a single pass through the FEL amplifier. Wavelengths from several millimeters to less than $10^{-6}$m can be amplified. (JDH)

20968 **Conference summary.** Henning, W. (Argonne National Lab., IL). *Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms;* **B5**: 443-446(1984).

Contributions to the conference on accelerator-based mass spectroscopy held in Rochester are summarized in this closing talk. Several technical advances are mentioned and a number of interesting applications are discussed. These last include carbon 14 dating and extra-terrestrial uses.

**20969 Intense, broadband, pulsed I-R source at the national synchrotron light source.** Williams, G.P. (Brookhaven National Lab., Upton, NY). *International Journal of Infrared and Millimeter Waves;* **5**: No. 6, 829-838(1984).

The authors describe a broadband (1 μm - 1 mm) synchrotron radiation infrared source, pulsed each 20-180 nseconds and delivering about $10^{15}$ photons/sec/1% bandpass into f10 optics. The source size is diffraction limited. This source is thus 100-1000 times brighter than a 2000 °K black body, very stable and capable of being used for calibration.

**20970 Accelerator mass spectrometry: from nuclear physics to dating.** Kutschera, W. (Argonne National Lab., IL). *Radiocarbon;* **25**: No. 2, 677-691(1983). Contract W-31-109-ENG-38.

Several applications of accelerator-based mass spectroscopy are reviewed. Among these are the search for unknown species, determination of comogenic radioisotopes in natural materials and measurements of half-lifes, especially those of significance to dating. Accelerator parameters and techniques of importance for these applications are also considered.

### 4304 Storage Rings

*REFER ALSO TO CITATION(S) 20950, 20952*

**20971 (BNL—52005) Workshop on compact storage ring technology: applications to lithography.** (Brookhaven National Lab., Upton, NY (USA)). 30 May 1986. Contract AC02-76CH00016. 51p. (CONF-860393—Summs.). NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87000993.

From Workshop on compact storage ring technology: applications to lithography; Upton, NY, USA (4 Mar 1986).

Project planning in the area of x-ray lithography is discussed. Three technologies that are emphasized are the light source, the lithographic technology, and masking technology. The needs of the semiconductor industry in the lithography area during the next decade are discussed, particularly as regards large scale production of high density dynamic random access memory devices. Storage ring parameters and an overall exposure tool for x-ray lithography are addressed. Competition in this area of technology from Germany and Japan is discussed briefly. The design of a storage ring is considered, including lattice design, magnets, and beam injection systems. (LEW)

## 44 INSTRUMENTATION

**20972 (E-EEA—323/10/1984) Verification and modification of the dc MOS-transitor model of Poorter. Thesis.** Feiken, J.J.A. (Technische Hogeschool Eindhoven (Netherlands)). 1984. 81p. (In Dutch). (ETN—86-98716). NTIS, PC A05/MF A01.

Modifications of the Poorter model for network analysis programs to describe modern MOS-transistors are discussed. The modified model is described by seven parameters each of which can be related to a certain physical phenomenon in the MOS transistor. The model parameters are determined by nonlinear optimization methods using the Marquardt algorithm. The parameters allow the calculation of the transistor characteristics. Comparison with measurements shows that the modified Poorter model describes some characteristics very accurately (2% to 3%); others are described with deviations as large as between 50% and 400%.

### 4401 Radiation Instrumentation

*REFER ALSO TO CITATION(S) 20048, 20144, 20154, 20155, 20156, 20389, 21294, 21492, 21523*

**20973 (CEA-N—2482) Study of the spectral and spatial response of organic plastic scintillators.** Bertin, A.; Frehaut, J.; Laget, J.P. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92 - Montrouge (France)). May 1986. 22p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751059.

It was established experimentally, for the scintillator NE 102 A, that energy is transmitted between primary and secondary solutes via photons of absorption length 66 μm in the medium. This process is typical of all ternary organic scintillators which in small thicknesses (approximately $<=100$ μm) behave therefore as binary scintillators. Owing to this effect moreover such ternary scintillators have a limited spatial resolution and are unsuitable for measurements of high spatial resolution and great amplitude dynamics, the analysis of X.ray spectra for example.

**20974 (CEA-N—2492) Use of parallel plate avalanche detectors for absolute photofission cross section measurement on $^{238}$U and $^{232}$Th.** Garganne, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Jul 1986. 42p. (In French). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751060.

This paper is a digest of a series of studies on parallel plate avalanche detectors, built with the purpose of measuring absolute photofission cross section on $^{238}$U and $^{232}$Th. Besides a few theoretical recallings, we describe the experimental configuration, and point out the various problems met during its elaboration, and their respective solutions.

**20975 (CONF-8609234—6) Test of a correlation chopper at a pulsed spallation neutron source.** Crawford, R.K.; Haumann, J.R.; Ostrowski, G.E.; Price, D.L.; Skoeld, K. (Argonne National Lab., IL (USA)). Aug 1986. Contract W-31109-ENG-38. 19p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004650.

From International collaboration on advanced neutron sources; Villigen, Switzerland (22 Sep 1986).

The correlation technique at a pulsed neutron spallation source using a mechanical pseudo-random chopper is found to be technically feasible and can be accomplished with relatively minor changes to a conventional chopper spectrometer. The strong variation of resolution with incident energy is a serious disadvantage for some applications. There may be specific instances in which the method is advantageous to the conventional chopper at such a source, but these remain to be identified. 8 refs., 5 figs.

**20976 (EFI—818(45)-85) Statistical decisions under nonparametric a priori information.** (Erevanskij Fizicheskij Inst. (USSR)). 1985. 22p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700864.

The basic module of applied program package for statistical analysis of the ANI experiment data is described. By means of this module tasks of choosing theoretical model most adequately fitting to experimental data, selection of events of definite type, identification of elementary particles are carried out. For mentioned problems solving, the Bayesian rules, one-leave out test and KNN (K Nearest Neighbour) adaptive density estimation are utilized. 12 refs.; 1 fig.; 2 tabs.

**20977 (IA—1406) Design and development of wide energy neutron REM equivalent spectrometer-dosimeters based on polycarbonates and Cr-39.** (Ben-Gurion Univ. of the Negev, Beersheba (Israel)). Mar 1985. 120p. NTIS (US Sales Only), PC A06/MF A01. File Number DE87700873.

This work describes a system composed of a REM response personnel neutron dosemeter, based on boron radiators and a polycarbonate track detector, for monitoring dose equivalents in the energy range 1 eV to 14 MeV, an electrochemical etching system for revealing damage sites in solid state track etch detectors, a

reader for magnifying the etched pits and a microprocessor for evaluating the dose equivalents and their uncertainties. The performance and directional dependence of the dosemeter when exposed to monoenergetic and polyenergetic neutron fields in the epithermal and fast energy regions are discussed. Saturation effects in polycarbonate foils are presented and a comparison is made between the response of polycarbonate and Cr-39 foils, used as passive detectors in the dosemeter. A new passive miniature fast neutron spectrometer-dosimeter is also described. The device is based on the detection of proton tracks by electrochemical etching of Cr-39 foils covered with thin polyethylene layers of different thicknesses. By means of this device it is possible to assess the fast neutron energy spectrum in 10 energy intervals in the energy range 0.5-15 MeV. Dose equivalents can be determined in the dose equivalent range 20 mREM to 8 REM, approximately 140 refs.; 62 figs.; 17 tables.

20978 (IA—1421, pp 176) **Improved fading estimation in environmental dosimetry with CaF/sub 2/:Tm thermoluminescent cards.** Ben-Shachar, B.; Laichter, Y.; German, U.; Weiser, G. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20979 (IA—1421, pp 191) **Design of a high efficiency neutron spectrometer for neutron multiplication reactions.** German, U.; Shani, G. (Israel Atomic Energy Commission, Tel Aviv; Ben-Gurion Univ. of the Negev, Beersheba, Israel). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

20980 (IAE—4063/15) **Automated complex for muon investigations.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 15p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700878.

Computerized measuring complex designed for recording $\mu$/sup +/ -> e/sup +/ - decay events is described. Electronic recording equipment comprises nanosecond program-controlled CAMAC units designed for performing time spectrometry. Complex software structure an examples for realization of some subprograms are presented. Control programs for the measuring equipment are written in the FORTRAN-4 language and its mass memory is 16 K words. 5 refs.; 5 figs.

20981 (IAEA-R—3478-F) **XRF of Zn and Pb in ores using radioactive source excitation. Final report for the period 1 June 1983-31 March 1986.** (International Atomic Energy Agency, Vienna (Austria)). Apr 1986. 42p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700885.

The apparatus for the simultaneous determination of Zn and Pb content in ores based on X-ray fluorescence analysis has been constructed and tested. The apparatus is basically a three channel proportional counter spectrometer using a Cadmium-109 annular source for the excitation of fluorescence radiation and Xe-filled proportional counter for its detection. The standard electronic processing line is terminated by three parallel single channel analyzers from which the pulses are fed through the I/O unit to a Sinclair Spectrum computer for counting and data evaluation. The electronic processing units are constructed in Eurocard system according to IAEA standards. The spectroscopy amplifier and S.C.A. units are based on IAEA nuclear electronics documentation. The computer is programmed for pulse accumulation and for the evaluation of Pb and Zn concentrations. Pulse accumulation is programmed in machine language while data evaluation is programmed in basic. The apparatus was tested for long term stability in an industrial laboratory use for three months. The acceptable reliability and stability of the system has been proved. 12 figs.

20982 (IAEA-R—3496-F) **Improving neutron spectrometer performances through spatial and focusing effects: Investigation of spatial correlation focusing influence on the resolution in diffraction and phonon scattering experiments. Final report for the period 1 August 1983-28 February 1986.** (International Atomic Energy Agency, Vienna (Austria)). Sep 1986. 37p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700886.

A consistent treatment of the optics of three-axis spectrometers with curved perfect crystals, the gradient of lattice spacing accounted for, is presented. The mosaic crystal case is treated within the same computational scheme. From the computational point of view, the perfect crystals case is not the zero mosaic spread limit of the mosaic crystals case. The estimation of the residual line-widths in conditions of reciprocal-space focusing allows the discussion of the possibilities and limitations of using spatial correlation effects for improving spectrometer performances. A computer programme is presented which makes it possible to calculate both analytically and numerically the optimal arrangements and the deviations of the optimal parameter values. The optimization of parameters not involved in the analytically expressed reciprocal-space focusing conditions is also possible with this programme. The experimental results presented in this paper show that both the linewidths and the absolute intensities can also be described with reasonable accuracy for the perfect curved crystals case. It is shown experimentally that even at low-flux reactors one can obtain with the aid of perfect curved crystals good resolutions at measurable intensities which are generally higher than those obtainable in conventional spectrometers with flat mosaic crystals. 28 refs, 8 figs.

20983 (IFVE-OEF—85-62) **Hodoscopic multiphoton spectrometer GAMS-2000.** Binon, F.; Lan'e, Zh.P.; Mishot, D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 35p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87700894.

A hodoscope $\gamma$-spectrometer comprising 1536 lead-glass cells is described. This detector allows to measure simultaneously the coordinates and the energies of a large number of gammas (up to approximately 10) and to determine the masses (with an accuracy of 1%) and the momenta of particles decaying into photons. The use of fast processors allows to select events by mass, energy and momentum transfer. The procedures of fully automatic calibration of the spectrometer in an electron beam (with a per cent accuracy) and of its control during long-term physical experiments are described. 48 refs.; 20 figs.

20984 (INIS-mf—10572, pp 41-42) **New trends in development of semiconductor radiation detectors.** Vidra, M. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701473. (CONF-8506335—Pt.2).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The history of the development of semiconductor detectors in Czechoslovakia is described and future trends anticipated. The development of semiconductor detectors will in the future be oriented to Ge(Li) detectors with efficiency higher than 25%. Development in the field of detectors based on high-purity germanium will be oriented mainly to coaxial detectors with volumes of up to 35 cm/sup 3/, with passivated surface allowing cycling. An integral part will be the development of small Dewar cryostats with liquid nitrogen container volumes of 1 to 3 litres for high-purity germanium detectors allowing temperature cycling.

20985 (INIS-mf—10574, pp 25-27) **Electron radiation dosimetry.** Janovsky, I. 1985. (In Czech). NTIS (US Sales Only), PC A05/MF A01. File Number DE87701448. (CONF-8506335—Pt.4).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The experience is reported gained with the dosimetry of electron radiation from linear high-frequency accelerators using

thin films and chemical systems. The calorimetric method was used for calibration. (B.S.).

20986 (INIS-mf—10575, pp 296-302) **Radiometric systems for controlling sorption and elution.** Svandelik, J. (Vyvojovy Zavod Uranoveho Prumyslu, Kamenna, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A05/MF A01. File Number DE87701445. (CONF-8510403—Exc.).

From Symposium on mining Pribram in science and technology; Pribram, Czechoslovakia (14 Oct 1985).

The applications are discussed in in-service control of the uranium content in eluates and in ion exchangers, of an industrial spectrometric unit linked to a JPR 12 computer and of the gamma spectrometry method of uranium determination. The technique using the industrial spectrometric unit is based on synchronous counting of pulses in the basic channel (/sup 235/U gamma radiation) and in the reference channel (/sup 241/Am). The use of radiometric systems of in-service control of the uranium content in eluates and in ion exchangers in agreement with the chemical analysis of samples increases the technical and economic importance of laboratory analytical chemistry. (J.C.).

20987 (INIS-SU—380, pp 60-61) **Microcavity solid detectors.** Khavroshkin, O.B.; Tsyplakov, V.V.; Tsarev, V.A.; Chechin, V.A. (AN SSSR, Moscow. Inst. Fiziki Zemli; AN SSSR, Moscow. Fizicheskij Inst.). 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780086.

Kratkie Soobshcheniya po Fizike. No. 5.

In Experimental and theoretical physics. Collection.

A new type of detector in which detection of ioniznq particles is based on formation of microcavities in stressed solid element is suggested. Local energy release along ionizing particle tracks leads to formation in this substance of microscopic defects-cracks. The formed cavities are detected either by optical methods or with secondary radiations accompanying their development: acoustic emission, radio emission, etc. After track data read out the voltage can be removed. This ceases cracks growth and can lead to their collapse. The device thus returns to initial state and can be used for further performance. The detector can be used also for detecting other local energy release sources: acoustic, optical and other signals.

20988 (INIS-SU—392, pp 517) **3.5-m time-of-flight alpha spectrometer with detectors on the base of microchannel electron multipliers.** Frolov, E.A. 1986. (In Russian). NTIS (US Sales Only), PC A99/MF A01. File Number DE87780053. (CONF-8604278—Summs.).

From 36. conference on nuclear spectroscopy and nuclear structure; Khar'kov, USSR (15 Apr 1986).

20989 (INIS-SU—392, pp 525) **On relativistic registration efficiency of microchannel electron multiplier in an electrostaic beta spectrometer.** Inoyatov, A.Kh.; Abdurazakov, A.A.; Brzhanson, Sh. 1986. (In Russian). NTIS (US Sales Only), PC A99/MF A01. File Number DE87780053. (CONF-8604278—Summs.).

From 36. conference on nuclear spectroscopy and nuclear structure; Khar'kov, USSR (15 Apr 1986).

20990 (INIS-SU—392, pp 528) **Determination of the ARGUS system sensitivity during cascade gamma photon detection.** Andrukhovich, S.K.; Berestov, A.V.; Zyazyulya, F.E.; Martsynkevich, B.A.; Rudak, Eh.A.; Khil'manovich, A.M. 1986. (In Russian). NTIS (US Sales Only), PC A99/MF A01. File Number DE87780053. (CONF-8604278—Summs.).

From 36. conference on nuclear spectroscopy and nuclear structure; Khar'kov, USSR (15 Apr 1986).

20991 (INIS-SU—392, pp 541) **SKT-04 multi-parameter semiconductor spectrometer in nuclear microanalysis.** Gamayunov, S.N.; Gurbich, A.F.; Majsyukov, V.D. 1986. (In Russian). NTIS (US Sales Only), PC A99/MF A01. File Number DE87780053. (CONF-8604278—Summs.).

From 36. conference on nuclear spectroscopy and nuclear structure; Khar'kov, USSR (15 Apr 1986).

20992 (INIS-SU—392, pp 576) **Si(Li)-detectors made of high-resistance p-type silicon with the area of 60 cm/sup 2/.** Muminov, R.A.; Bajzakov, B.B.; Trubitsyn, Yu.V.; Radzhapov, S.A.; Khasanov, D.K. 1986. (In Russian). NTIS (US Sales Only), PC A99/MF A01. File Number DE87780053. (CONF-8604278—Summs.).

From 36. conference on nuclear spectroscopy and nuclear structure; Khar'kov, USSR (15 Apr 1986).

20993 (INIS-SU—392, pp 531) **On some specific features of heavy charged particle detection by semiconductor detectors.** Kushniruk, V.F. 1986. (In Russian). NTIS (US Sales Only), PC A99/MF A01. File Number DE87780053. (CONF-8604278—Summs.).

From 36. conference on nuclear spectroscopy and nuclear structure; Khar'kov, USSR (15 Apr 1986).

20994 (INPE—3797) **Gamma-ray background induced in a double Ge (Li) spectrometer at balloon altitudes in the hemisphere.** (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). Feb 1986. 26p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700927.

A double coaxil Ge(li) spectrometer has been flown for the first time in December, from the Southern Hemisphere and the induced background at ceiling in the diodes was studied. During the flight, different anti-coincidence modes were operated to estimate the gamma-ray lines. The results of 511 Kev line show that the fluxes detected by the upper diode are in good agreement with previous measurements, and indicate a probable contamination of the lower diode.

20995 (INR—1932/3/E/B) **Linear ratemeter with automatic range control.** (Institute of Nuclear Research, Warsaw (Poland)). 1982. 27p. (In Polish). Power System Computer Centre. Mining and Power System Information Department, Palace of Culture and Science, PL-00-901 Warsaw, Poland.

The linear ratemeter with automatic range control is described. The results of measurements are shown on the diagrams.

20996 (IPEN-Pub—86) **Determination of boron in aqueous solutions by solid state nuclear track detectors technique, using a filtered neutron beam.** (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). Nov 1985. 9p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700935.

The solid state nuclear track detectors technique has been used for determination of boron in aqueous solutions, using a filtered neutron beam. The particles tracks from the /sup 10/ B(n,$\alpha$)Li/sup 7/ reaction were registered in the CR-39 film, chemically etched in a (30%) KOH solution 70/sup 0/C during 90 minutes. The obtained results showed the usefulness of this technique for boron determination in the ppm range. The inferior detectable limit was 9 ppm. The combined track registration efficiency factor K has been evaluated in the solutions, for the CR-39 detector and its values is K= (4,60 -/sup +/ 0,06). 10 /sup -4/ cm.

20997 (ITEF—85(1985)) **Use of the Ksub(892)sup(*+-) resonance as an indicator of systematic distortions for the 2 meter hydrogen liquid ITEhF chamber.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 7p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700973.

$\pi$/sup -/p -> K/sup 0/$\pi$/sup -+/ + X inclusive reaction is considered. The conclusions on correctness of charged particle identification (K/sup -+/, $\pi$/sup -+/) in the 2m ITEPh hydrogen liquid chamber and and recognition of K/sup 0/-mesons, $\Lambda$-hyperons, e/sup +/e/sup -/-pairs are made on the base of K$\sigma$ub(892)sup(+-)(-> K/sup 0/$\pi$/sup ++/) resonance observation. 6 refs.; 6 figs.

20998 **(ITEF—132(1985)) Wide-aperture multichannel threshold high-pressure Cherenkov detector.** Abramov, B.M.; Kishkurno, V.V.; Kulikov, V.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700978.

The design and test results of an eight-channel wide-aperture threshold Cherenkov detector for 6 atm. pressure, 1.0 x 1.6 m/sup 2/ aperture with 1.5 m long radiator are described. The detector is necessary for identification of charged particles escaping from the magnet window of the 3-m spectrometer in a wide range of coordinates and angles. It is supposed to be used, primarily, for separation of protons and $\pi$/sup +/-mesons in experiments on study of $\pi$N-interactions with baryon exchange. 3 refs.; 5 figs.; 4 tabs.

20999 **(ITEF—147(1985)) Measurement of resolution functions using hadronic energy in antineutrino experiment at 15-foot Ne-H/sub 2/ bubble chamber.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 20p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700981.

Calibration measurements of hadronic events at 15-foot Ne-H/sub 2/ bubble chamber initiated by 1, 3.2, 5.6, 9.5, 25 and 50 GeV hadrons were carried out. Measurements were performed using technique of the E180 antineutrino experiment. Resolution functions in hadronic energy and total momentum of an event are presented. 5 refs; 8 figs.; 2 tabs.

21000 **(JEN—590) Three L-subshells atomic model to compute counting efficiency of electron-capture nuclides.** (Junta de Energia Nuclear, Madrid (Spain)). 1986. 39p. (In Spanish). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701481.

A three L-subshells and K, M-shells atomic model is developed in order to obtain the counting efficiency in liquid scintillation counting. Mathematical expressions are given to calculate the probabilities of 264 different atomic rearrangement ways so as to determine corresponding effective energies. This new model will permit the testing of the influence of the different atomic and nuclear parameters upon the counting efficiency nuclides of low and medium atomic number decaying by electron capture. 8 refs.

21001 **(JINR—E-1-86-87) Longitudinal development of electromagnetic shower produced by 5 and 9 GeV positrons in lead glass.** (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1986. 4p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701484.

Submitted to the journal Nucl. Instrum. Methods.

With the aim of studying a longitudinal development of electromagnetic shower in TF-1-000 lead glass a special counter has been designed. Measurements were performed on the 5 and 9 GeV positron beam. The shower energy deposition has been detected by the Cherenkov radiation measured at the 1 to 19 radiation lengths. The results of experimental data approximation are presented, and the place of cascade curve maximum is defined. 10 refs; 4 figs.; 1 tab.

21002 **(JINR—E-6-85-536) Experimental determination of relative light conversion factors of TLD-100 for protons with energies from 2.0 to 9.0 MeV.** (Joint Inst. for Nuclear Research, Dubna (USSR). Dept. of Radiation Safety). 1985. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701482.

Relative light conversion factors (RLCF) for heavy charged particles (protons, deuterons, recoils) are needed for the calculation of the neutron sensitivity of thermoluminescent (TL) detectors. Such light conversion factors can be determined experimentally. A method is represented for the experimental determination of RLCF. The described experimental facility gives the possibility of irradiation of different luminophor samples with heavy charged particles and flux determination and particle spectrometry at the same time. For the determination of RLCF the doses are needed which are applicated at the irradiation with heavy charged particles and gamma radiation, respectively, and the according detector readings at the TL evaluation. The problems arising at the dose determination are discussed. With this experimental facility the RLCF for TLD-100 for protons were determined. The relative light conversion factors determined according to the light sum method as well as the peak height method are summarizinhly represented and discussed. Furthermore a comparison of the glow curves is made after gamma and proton irradiation. 15 refs.; 6 figs.; 2 tabs.

21003 **(JINR—E-13-86-28) Assessment of the parameters of a setup for searches for nucleon decay and neutron oscillation by detecting multiple neutron events in massive samples.** (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1986. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701483.

Submitted to the journal Instrum. Methods Phys. Res. .

The parameters of a detector designed for detecting nucleon decay and/or the oscillations of a neutron bound in the atomic nucleus are estimated by observing multiple neutron emission events in massive samples. Calculations have been carried out for the detection efficiency and for spatial distribution of the points at which the single neutrons emitted from a point source had to be detected, for different variants of detector geometry. To evaluate the background characteristics of the detector, calculations have been performed for the multiplicities and spatial distributions of the points of formation of secondary neutrons occuring in the interactions of 0.3-1 GeV nucleons with infinite lead units. It is shown that the comparison of the spatial distribution of the points of neutron detection for nucleon decay or the neutron oscillation phenomena and the background processes allows one to suppress the cosmic-ray background of the detector by a factor of more than 10. 15 refs.; 7 figs.

21004 **(Juel-Spez—363) BIG KARL magnet spectrometer operating system. User's manual.** Meissburger, J. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Kernphysik). Jul 1986. 326p. NTIS (US Sales Only), PC A15/MF A01. File Number DE87751292.

In this manual instructions for the use of the computer codes for spectrometer control, data acquisition and analysis, spectrometer operation, and general user supports are presented. (HSI).

21005 **(LA—10916-MS) Design report on a 10-in. multiwire proportional chamber (MWPC) and associated electronics.** MacArthur, D.W. (Los Alamos National Lab., NM (USA)). Feb 1987. Contract W-7405-ENG-36. 26p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006318.

We discuss the design and specifications of a 10-in. x 10-in. active area wire chamber. Several of these chambers will be combined with polyethylene converters to make a large volume detector intended for use as a high-energy detector displaying moderate energy resolution. We also discuss the amplifiers and discriminators that have been designed for these chambers. This report only concerns the wire chambers and electronics.

21006 **(LBL—17804) A low background-rate detector for ions in the 5 to 50 keV energy range to be used for radioisotope dating with a small cyclotron.** Friedman, P.G. (California Univ., Berkeley (USA)). 25 Nov 1986. Contract AC03-76SF00098. 101p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87006171.

Accelerator mass spectrometry in tandem Van de Graaff accelerators has proven successful for radioisotope dating small samples. We are developing a 20 cm diameter 30 to 40 keV cyclotron dedicated to high-sensitivity radioisotope dating, initially for $^{14}C$. At this energy, range and dE/dx methods of particle identification are impossible. Thus arises the difficult problem of reliably detecting 30 to 40 keV $^{14}C$ at $10^{-3}$ counts/sec in the high background environment of the cyclotron, where lower energy ions, electrons, and photons bombard the detector at much higher rates. We have developed and tested an inexpensive, generally useful ion detector that allows dark-count rates below $10^{-4}$ counts/sec and excellent background suppression. With the cyclotron tuned near the $^{13}CH$ background peak, to the frequency for $^{14}C$, the detector suppresses the background to 6 x $10^{-4}$ counts/sec. For each $^{14}C$ ion the detectors grazing-incidence $Al_2O_3$ conversion dynode emits about 20 sec-

ondary electrons, which are independently multiplied in separate pores of a microchannel plate. The output signal is proportional to the number of secondary electrons, allowing pulse-height discrimination of background. We have successfully tested the detector with positive $^{12}C$, $^{23}Na$, $^{39}K$, $^{41}K$, $^{85}Rb$, $^{87}Rb$, and $^{133}Cs$ at 5 to 40 keV, and with 36 keV negative $^{12}C$ and $^{13}CH$. It should detect ions and neutrals of all species, at energies above 5 keV, with good efficiency and excellent background discrimination. Counting efficiency and background discrimination improve with higher ion energy. The detector can be operated at least up to 2 x $10^{-7}$ Torr and be repeatedly exposed to air. The maximum rate is 10/sup 6.4/ ions/sec in pulse counting mode and 10/sup 9.7/ ions/sec in current integrating mode.

21007 **(NAC—86-01) 15 channel 2- and 3-fold coincidence counting system for radioactivity standardization.** (Council for Scientific and Industrial Research, Pretoria (South Africa). National Accelerator Centre). 1986. 39p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87701485.

The $4\pi$ $\beta$-$\gamma$ liquid scintillation coincidence counting system which is used at the National Accelerator Centre for standardizing radioisotopes, has been extended to allow for up to fifteen data points to be measured simultaneously by introducing a 15-fold coincidence unit and a 32-channel scaler into the system. A new control/data acquisition computer program has been written and its operation explained in detail. The advantages of the new system are discussed, and the activity of a /sup 139/Ce source as measured by the new system and the old 3-fold system is compared.

21008 **(PB—87-125233/XAB) High-sensitivity photodiodes for bismuth germanate scintillation detectors. Final report.** Squillante, M.R.; Entine, G. (Radiation Monitoring Devices, Inc., Watertown, MA (USA)). Jul 1984. 18p. NTIS, PC A02/MF A01.

The silicon-avalanche photodiode was investigated as an alternative to available silicon photodiodes. The device is a solid-state photosensor fabricated on a thin wafer of silicon, which has internal gain. Avalanche photodiodes can have high internal gain which when coupled to a scintillator crystal, results in a sensitive and compact nuclear detector. The importance of the compactness for high-energy physics experimentation, especially in magnetic fields, is discussed. The solid-state nature of the photodetector renders it more stable, reducing the need for recalibration and adjustment. The program has demonstrated the suitability of the newly developed, large-area, blue-sensitive avalanche photodiode for use in high-energy physics experimentation.

21009 **(PPA-T—25) Calibration process of survey meters and dosemeters at Standard Dosimetry Laboratory, Nuclear Energy Unit, Malaysia.** (Unit Tenaga Nuklear, Bangi, Selangor (Malaysia)). 1983. 31p. (In Malay). Nuclear Energy Unit, Kompleks PUSPATI, 43000 Kajang (MY).

Techniques of calibration and its possible uses are reviewed and discussed. Three main techniques identified are substitution, simultaneous irradiation and inverse square law. The scope of application of each technique is discussed in detail. In addition, tests which are performed on the calibrated dosemeters including energy dependence, angular dependence as well as linearity are explained. For the above purposes, photon radiations from 30 keV to 1250 keV were used. The radiations are obtained by means of an X-ray machine, PHILIPS Model MCN 32, Cs 137 and C/sup 60/. At the end of the report, several forms tht are required for giving the calibration services are attached.

21010 **(UCID—20968) Determination of equivalent weight of epoxides.** Selig, W.S. (Lawrence Livermore National Lab., CA (USA)). 15 Jan 1987. Contract W-7405-ENG-48. 4p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87005205.

Hydrogen bromide is generated in situ by the addition of perchloric acid to quaternary ammonium bromide. The HBr rapidly opens the oxirane (epoxide) ring. The excess hydrogen bromide is sensed and indicated by the electrode couple in the potentiometric titration. 2 refs.

21011 **Semiconductor detectors and readout electronics: Present directions and outstanding problems. An introduction to the symposium.** Radeka, V. (Brookhaven National Lab., Upton, NY, USA). *Nuclear Instruments and Methods in Physics Research;* **253**: No. 3, 309-312(15 Jan 1987). (CONF-8603109—). Contract AC02-76CH00016.

From 4. European symposium on semiconductor detectors; Munich, F.R. Germany (3 Mar 1986).

The interest and activity in the development of semiconductor detectors with high position resolution has been increasing in the last six years. This activity has been stimulated by the need for high precision particle tracking in recent and proposed experiments in high energy physics and, to a lesser extent, by the need for X-ray position detection in some experiments with synchrotron radiation. The new developments and interest have resulted in a large number of publications and, sometimes, in a too high frequency of workshops and meetings. (orig./HSI).

21012 **Test beam results for silicon microstrip detectors with VLSI readout.** Adolphsen, C.; Litke, A.; Schwarz, A.; Turala, M.; Lueth, V.; Breakstone, A.; Parker, S. (California Univ., Santa Cruz, USA. Inst. for Particle Physics; Stanford Linear Accelerator Center, CA, USA; Hawaii Univ., Honolulu, USA). *Nuclear Instruments and Methods in Physics Research;* **253**: No. 3, 444-449(15 Jan 1987). (CONF-8603109—). Contract AC03-76SF00515;AA03-76SF00034;AC03-83ER40103.

From 4. European symposium on semiconductor detectors; Munich, F.R. Germany (3 Mar 1986).

A telescope consisting of three silicon microstrip detectors has been tested in a high energy positron beam at SLAC. Each detector has strips with 25 $\mu$m pitch and is read out by two 128-channel NMOS integrated circuits (Microplex). Results on the signal-to-noise ratio, spatial resolution, and two-track separation are given.

21013 **Germanium drift detector: A new tomographic device providing information on the chemical properties of a body section.** Gatti, E.; Rehak, P.; Kemmer, J. (Brookhaven National Lab., Upton, NY, USA; Technische Univ. Muenchen, Garching, Germany, F.R. Fakultaet fuer Physik). *Nuclear Instruments and Methods in Physics Research;* **253**: No. 3, 511-518(15 Jan 1987). (CONF-8603109—). Contract AC02-76CH00016.

From 4. European symposium on semiconductor detectors; Munich, F.R. Germany (3 Mar 1986).

A system to analyze the chemical properties of a region of tissue located deep inside the human body without having to penetrate the body is proposed. The method is based on a high precision detection of X-rays or $\gamma$-rays (photons) from an external source Compton scattered from the tissue under inspection.

21014 **Silicon position sensitive detectors for the Helios (NA 34) experiment.** Beuttenmuller, R.H.; Di Nardo, R.P.; Kraner, H.W.; Ludlam, T.W.; Polychronakos, V.A.; Radeka, V.; Bisi, V.; Giubellino, P.; Ramello, L.; Chesi, E. (Brookhaven National Lab., Upton, NY, USA; Turin Univ., Italy). *Nuclear Instruments and Methods in Physics Research;* **253**: No. 3, 500-510(15 Jan 1987). (CONF-8603109—). Contract AC02-76CH00016.

From 4. European symposium on semiconductor detectors; Munich, F.R. Germany (3 Mar 1986).

Also published as report BNL--37899; CONF-8603109--1.

Silicon detectors having both "pad" and strip positon sensitive configurations have been fabricated for the Helios experiment which requires an elaborate pulse height-dependent trigger as well as one dimensional silicon strip position sensing. The trigger detector is a 400 element, 30 mm diameter detector with readout connections from a ceramic overlay board. Tests with full prototype detectors have shown essentially 100% detection efficiency and excellent pulse height resolution well capable of delineating 0, 1 or 2 hits per pad. Strip detectors with 25 $\mu$m pitch and a varying readout pitch have been tested, which utilize both capacitive and resistive charge division. Techniques for realization of required interstrip resistors will be discussed and results which may compare these readout methods will be reported.

21015 **Wedge and strip image readout systems for photon-counting detectors in space astronomy.** Siegmund, O.H.W.; Lampton, M.; Bixler, J.; Chakrabarti, S.; Vallerga, J.; Bowyer, S.; Malina, R.F. (Space Sciences Laboratory, University of California, Berkeley, California 94720). *Journal of the Optical Society of America A: Optics and Image Science;* **3**: No. 12, 2139-2145(Dec 1986).

We discuss the application of wedge and strip anodes to photon-counting microchannel plate detector systems for the extreme and far ultraviolet. Performance data, obtained as a result of calibration of the Extreme Ultraviolet Explorer (EUVE) [Proc. Soc. Photo-Opt. Instrum. Eng. 279, 176 (1981)] satellite detectors (open face) and the FAUST-Spacelab [Space Sci. Instrum. 5, 21 (1979)] far-ultraviolet sensors (sealed tube), are presented. We have achieved CsI quantum detection efficiencies of —80% at 114 A and —40% at 600 and 1300 A that we believe to be the highest ever obtained. Position sensitivity of $<10$ $\mu$m is demonstrated, and the position resulution, image linearity, background rate, and flat-field characteristics are discussed.

21016 **Monte Carlo studies of uranium calorimetry.** Brau, J.; Gabriel, T.A. (Univ. of Tennessee, Knoxville). *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors, and Associated Equipment;* **A238**: 489-495(1985). Contract AS05-76ER03956;AC05-84OR21400.

Detailed Monte Carlo calculations of uranium calorimetry are presented which reveal a significant difference in the responses of liquid argon and plastic scintillator in uranium calorimeters. Due to saturation effects, neutrons from the uranium are found to contribute only weakly to the liquid argon signal. Electromagnetic sampling inefficiencies are significant and contribute substantially to compensation in both systems.

21017 **Absolute efficiency of Kimfol films for counting fission fragments emerging from thick sources.** Yeh, T.R.; Lancman, H. (Brooklyn College of CUNY, NY). *Nuclear Instruments and Methods in Physics Research;* **179**: 141-145(1981). Contract AC02-79ER10452.

The absolute efficiency of 8 $\mu$m thick Kimfol films for counting fission fragments emerging from thick foils has been determined experimentally as a function of the depth in the foil at which the fission fragments are emitted and the angle they make relative to the normal to the foil. The accuracy of the efficiency determination was checked by measuring the counting rate of spontaneous fission fragments from thick foils of uranium and determining the probability of spontaneous fission of $^{238}$U from the data. The obtained value of $\lambda$/sub SF/ $= (7.5 +/- 0.6) \times 10^{-17}$ y$^{-1}$ is in close agreement with $\lambda$/sub SF/ $= 7 \times 10^{-17}$ y$^{-1}$ the accepted value in fission track dating. 17 references, 8 figures.

## 4402 Radiation Effects On Instrument Components, Instruments, Or Electronic Systems

*REFER ALSO TO CITATION(S) 20551*

21018 (INIS-SU—392, pp 568) **On the improvement of silicon detector characteristics under radiation effects.** Barabash, L.I.; Kibkalo, T.I.; Litovchenko, P.G.; Rozenfel'd, A.B.; Khivrich, V.I. 1986. (In Russian). NTIS (US Sales Only), PC A99/MF A01. File Number DE87780053. (CONF-8604278—Summs.).

From 36. conference on nuclear spectroscopy and nuclear structure; Khar'kov, USSR (15 Apr 1986).

## 4403 Miscellaneous Instruments

*REFER ALSO TO CITATION(S) 20202, 20840, 20968, 20970, 21472*

21019 (BDX—613-3606) **Applications of lower cost computers to dimensional gaging: Topical report.** Hines, R.E. (Allied Corp., Kansas City, MO (USA). Bendix Kansas City Div.). Feb 1987. Contract AC04-76DP00613. 28p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005730.

Small, lower cost microcomputers have been used in two computer-assisted gaging applications. Both provide capabilities that would be difficult and time-consuming to obtain by manual methods. A calculator and eight LVDT gage heads measure the thickness of a part at 64 evenly spaced locations. The computer applies complex secondary tolerances that have permitted the product yield to increase to 95% from the previous 50%. A microcomputer uses two LVDT gage heads to measure the inside and outside diameters and roundness of other parts. Measurements are taken automatically at 16 equally spaced locations as the product rotates past the probes.

21020 (BNL—38825) **A thin-collector Bayard-Alpert gauge for $10^{-12}$ Torr vacuum.** Hseuh, H.C.; Lanni, C. (Brookhaven National Lab., Upton, NY (USA)). 16 Oct 1986. Contract AC02-76CH00016. 5p. (CONF-8611127—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87002390.

From UHV gauging workshop; Gaithersburg, MD, USA (3 Nov 1986).

The changes in the sensitivity (S) and the equivalent X-ray limit (P/sub x/) of several Bayard-Alpert gauges (BAGs) were studied when the size of the collectors was reduced from 125 $\mu$ to 50 $\mu$ and when different mounting envelopes were used. Based on this study, 400 custom BAGs with 50 $\mu$ collector were purchased from a vendor. The S and the P/sub x/ of these thin-collector BAGs were also measured.

21021 (DOE/METC—86/6069) **Proceedings of the instrumentation, components, and materials contractors meeting.** Hobday, J.M. (ed.). (USDOE Morgantown Energy Technology Center, WV). Jan 1987. 295p. (CONF-860961—). NTIS, PC A13/MF A01; GPO Dep. File Number DE86006596.

From Instrumentation, components and materials contractors' meeting; Morgantown, WV, USA (16 Sep 1986).

The first combined Instrumentation, Components, and Materials Contractors Meeting was held September 16 to 17, 1986, at the Sheraton Lakeview Conference Center in Morgantown, West Virginia. Work presented at the meeting was sponsored by the US Department of Energy, Office of Fossil Energy, and directed by the Morgantown Energy Technology Center (METC), which served as host. Attendance included representatives from industry, academia, National Laboratories, and other Government agencies and totaled 85 individuals. This and similar meetings focusing on specific topics are organized periodically by METC to provide a forum for exchange of information between DOE contractors and interested parties. The Proceedings have been reproduced from camera-ready manuscripts furnished by the authors. The manuscripts have not been refereed, nor have they been extensively edited. Papers have been entered individually into EDB and ERA.

21022 (JEN—591) **Islam project: interface between the signals from various experiments of a Van de Graaff accelerator and PDP 11/44 computer.** (Junta de Energia Nuclear, Madrid (Spain)). 1986. 35p. (In Spanish). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701486.

An interface between the signals from an in-beam experiment of a Van de Graaff accelerator and PDP 11/44 computer is described. The information corresponding to one spectrum is taken from one digital voltimeter and is processed by means of an equipment controlled by a M6809 microprocessor. The software package has been developed in assembly language and has a size of 1/2 K. 12 figs.

21023 (KFKI—1986-63/G) **Measurement of reactivity temperature coefficient by noise method in power reactors. Theory.** (Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics). Sep 1986. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701487.

A model is presented for the estimation of the reactivity temperature coefficient of nuclear reactors. The model is based on the point kinetic approach and it uses the power fluctuations due to a small reactivity fluctuation. The parameters come from the measuring of the power noise spectra by neutron detectors and tempera-

ture sensors. The effect of the gas content on the temperature coefficient is analyzed, the dependendence of the parameters on the void fraction is derived. The suggested method can be used for BWR and PWR reactors as well. Experimental test of the method is performed at the reactor of Unit 2 of the Paks Nuclear Power Plant by ex-core neutron detectors and fuel assembly thermocouples. (D.Gy.). 11 refs.; 1 fig.

21024 (N—87-13704) **Proceedings of the Second Infrared Detector Technology Workshop.** Mccreight, C.R. (National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center). Feb 1986. 348p. (NASA-TM—88213; A—86123; NAS—1.15:88213; CONF-8508227—). NTIS, PC A15/MF A01.

From 2. infrared detector technology workshop; Moffett Field, CA, USA (13 Aug 1985).

The workshop focused on infrared detector, detector array, and cryogenic electronic technologies relevant to low-background space astronomy. Papers are organized into the following categories: discrete infrared detectors and readout electronics; advanced bolometers; intrinsic integrated infrared arrays; and extrinsic integrated infrared arrays. Status reports on the Space Infrared Telescope Facility (SIRTF) and Infrared Space Observatory (ISO) programs are also included.

21025 (N—87-13704, pp vp) **Ge:Be infrared photoconductors.** Haegel, N.M.; Haller, E.E. Feb 1986. NTIS, PC A15/MF A01. (NASA-TM—88213; A—86123; NAS—1.15:88213; CONF-8508227—).

From 2. infrared detector technology workshop; Moffett Field, CA, USA (13 Aug 1985).

Ge:Be photoconductors were optimized for the 30 to 50 micron wavelength range. Crystal growth of detector quality material requires good control of both the Be and residual impurity doping. Detective quantum efficiencies of n sub d = 46% at 5 A/W were achieved at a photon background of 10 to the 8th power p/s. The responsivity of Ge:Be detectors can be strongly temperature-dependent when the residual shallow levels in the material are closely compensated. Transient responses on the order of approximately 1 second were observed in some materials. The role of residual shallow impurities on the performance of photoconductors doped with semi-deep and deep impurities is discussed.

21026 (N—87-13704, pp vp) **Status of NTD Ge bolometer material and devices.** Haller, E.E.; Haegel, N.M.; Park, I.S. Feb 1986. NTIS, PC A15/MF A01. (NASA-TM—88213; A—86123; NAS—1.15:88213; CONF-8508227—).

From 2. infrared detector technology workshop; Moffett Field, CA, USA (13 Aug 1985).

More was learned about the physics of hopping conduction at very low temperatures, which will be important for bolometer design and operation at ever decreasing temperatures. Resistivity measurements were extended down to 50 mK. At such low temperatures, precise knowledge of the neutron capture cross sections sigma (sub n) of the various Ge isotopes is critical if one is to make an accurate prediction of the dopant concentrations and compensation, and therefore resistivity, that will result from a given irradiation. An empirical approach for obtaining the desired resistivity material is described and the process of conducting a set of experiments which will improve the knowledge of the effective sigma (sub n) values for a given location in a particular reactor is discussed. A wider range of NTD Ge samples is now available. Noise measurements on bolometers with ion implanted contacts show the no 1/f noise component appears down to 1 Hz and probably lower.

21027 (N—87-13704, pp vp) **Characterization of NTD germanium and ion-implanted Si bolometers at 0.3K and 0.1K.** Moseley, H.; Kelley, R.; Szymkowiak, A.E.; Juda, M.; Mccammon, D.; Zhang, J.; Haller, E.E. (Wisconsin Univ., Madison; California Univ., Berkeley). Feb 1986. NTIS, PC A15/MF A01. (NASA-TM—88213; A—86123; NAS—1.15:88213; CONF-8508227—).

From 2. infrared detector technology workshop; Moffett Field, CA, USA (13 Aug 1985).

Bolometer elements were built and tested using NTD germanium and ion-implanted Si thermometer elements. The thermal links were made using aluminum wires and NbC(x)N(y) coated carbon fibers. The temperature dependence of the detector resistance, lead thermal conductivity, and heat capacity were measured. The dependence of the detector resistance on applied electric field was also measured. This, combined with the current-voltage curve for the detector, allowed the calculation of the detector responsivity. Known amounts of energy were deposited into the detector by allowing x rays from the decay of Fe-55 to be thermalized in the detector. In the best-measured case, the predicted pulse height/measured height was 1.04 + or - .05. The noise at frequencies above 25 Hz in the NTD Ge was near that predicted by thermodynamics. The noise below 25 Hz has a 1/f character and may be in the carbon fiber/bolometer junction. The implanted detectors show some 1/f noise which depends on the total thermometer volume. Comparison between noise measurements and theory will be presented.

21028 (N—87-13704, pp vp) **Characterization of 2.5 microns HgCdTe detectors for low-background applications.** Depoy, D.L.; Hall, D.N.B. Feb 1986. NTIS, PC A15/MF A01. (NASA-TM—88213; A—86123; NAS—1.15:88213; CONF-8508227—).

From 2. infrared detector technology workshop; Moffett Field, CA, USA (13 Aug 1985).

A program of testing aimed at the evaluation of systems that have the potential to provide the level of performance required for use in space-based instruments was undertaken and their usefulness appraised for astronomy. The results of the first phase of the program to characterize selected pixels of a HgCdTe photovoltaic array detector were reported.

21029 (N—87-13704, pp vp) **Evaluation of Rockwell HgCdTe arrays for astronomical use.** Lebofsky, M.J.; Montgomery, E.F.; Kailey, W.F. Feb 1986. NTIS, PC A15/MF A01. (NASA-TM—88213; A—86123; NAS—1.15:88213; CONF-8508227—).

From 2. infrared detector technology workshop; Moffett Field, CA, USA (13 Aug 1985).

The 32 x 32 HgCdTe array manufactured by Rockwell International was proven to be a highly competitive detector type for use at wavelengths shorter than 2.5 microns. The goal of a K=+16 sky survey using this array attached to the Steward Observatory Transit Telescope is clearly within reach. The detector material exhibits high quantum efficiency and low dark currents indicating that its usefulness may extend beyond its use with a CCD readout on groundbased telescopes.

21030 (N—87-13704, pp vp) **Si:As BIB detector arrays.** Bharat, R.; Petroff, M.D.; Speer, J.J.; Stapelbroek, M.G. Feb 1986. NTIS, PC A15/MF A01. (NASA-TM—88213; A—86123; NAS—1.15:88213; CONF-8508227—).

From 2. infrared detector technology workshop; Moffett Field, CA, USA (13 Aug 1985).

Highlights of the results obtained on arsenic-doped silicon blocked impurity band (BIB) detectors and arrays since the invention of the BIB concept a few years ago are presented. After a brief introduction and a description of the BIB concept, data will be given on single detector performance. Then different arrays that were fabricated will be described and test data presented.

21031 (N—87-13704, pp vp) **Study of Si:In hybrid surface channel IRCCD devices.** Tollestrup, E.; Capps, R.W. Feb 1986. NTIS, PC A15/MF A01. (NASA-TM—88213; A—86123; NAS—1.15:88213; CONF-8508227—).

From 2. infrared detector technology workshop; Moffett Field, CA, USA (13 Aug 1985).

Hybrid silicon Infrared Charge Coupled Devices (IRCCDs) are evaluated for use as viable astronomical detectors. A Si:In photoconductor array, which is bump-bonded to a silicon multiplexer, is described. A summary of the device parameters is given.

21032 (N—87-13704, pp vp) **Development of 58 x 62 Si:Sb detector arrays.** Worley, S.; Gaalema, S. Feb 1986. NTIS, PC A15/MF A01. (NASA-TM—88213; A—86123; NAS—1.15:88213; CONF-8508227—).

From 2. infrared detector technology workshop; Moffett Field, CA, USA (13 Aug 1985).
Interim Report.
The fabrication of antimony doped silicon (Si:Sb) detector arrays are described for use in 30 micron infrared imaging applications. The operation of the multiplexer readout circuit which will be used for this application is also described.

21033 (N—87-13704, pp vp) **Evaluation of a Si:Ga direct readout array.** Lamb, G.M.; Shu, P.S.; Lokerson, D.C.; Gezari, D.Y.; Bowser, J. (Science Applications Research, Lanham, MD). Feb 1986. NTIS, PC A15/MF A01. (NASA-TM—88213; A—86123; NAS—1.15:88213; CONF-8508227—).
From 2. infrared detector technology workshop; Moffett Field, CA, USA (13 Aug 1985).
Preliminary results from the Hughes 58 x 62 gallium-doped silicon infrared array are presented. The device functioned predictably and repeatedly at the low temperatures for the Space Infrared Telescope Facility (SIRTF). Power dissipation was reduced to acceptable levels while still maintaining the device speed. The infrared response was excellent and the degree of anomalous effects was compatible to conventional photoconductors.

21034 (N—87-13704, pp vp) **Evaluation and characterization of hybrid arrays.** Arens, J.F.; Peck, M.C. Feb 1986. NTIS, PC A15/MF A01. (NASA-TM—88213; A—86123; NAS—1.15:88213; CONF-8508227—).
From 2. infrared detector technology workshop; Moffett Field, CA, USA (13 Aug 1985).
An Infrared Camera was built for astronomical observations and for testing arrays for satellite based work. The detectors are sensitive to mid infrared wavelengths. The camera was tested at the University of Arizona 61 and 90 inch telescopes and the NASA IRTF. These tests have demonstrated a sensitivity consistent with photon shot noise with an approximately 10% quantum efficiency for each pixel when the camera was used with a 1.6% spectral filter or when used with a Fabry-Perot having a resolving power of 2000. Initial measurements of read out noise, dark current, cross talk, and hysteresis were made. The detector chip in current use is a hybrid array manufactured by the Hughes Aircraft Company. Because part of the goal was to develop and advance technology, it was decided to work with a switched MOSFET array. This architecture is very promising, and the detector parameters will be quantified carefully.

21035 (NP—7770072) **Dynamic measuring of combustion engine torque.** Wuechner, E. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Maschinenbau). 11 Jul 1985. 112p. (In German). NTIS (US Sales Only), PC A06/MF A01. File Number DE87770072.
Determination of the torque from engine speed through measuring is unfavourably influenced by unwanted frequency caused mainly by rotary oscillations of the crankshaft. Deduction errors of the torque can be avoided without resorting to a low-pass filter, if a time measurement. The basis for determining torque-speed characteristics and for calculating torque fluctuations above the crank angle is explained. Detailed description of the precision of dynamic torque measuring and the practical application (inductive transducer, type of electronic circuit storing of measured values, data processing). Measuring results on: torques of test engines, drag measurement, full load measurement with upper dead center metering (crankshaft rotation). The process is very useful for diagnosis as it is quick and needs little apparatus. (HWJ).

21036 (RFP—3845) **Modification of a Scintrex UA-3 Uranium Analyzer for glovebox use.** Herman, C.W.; Michel, C.E.; Weiss, J.R.; Salvione, D.E. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 4 Aug 1986. Contract AC04-76DP03533. 26p. NTIS MF A01; 2; GPO Dep. File Number DE87005796.
A Scintrex UA-3 Uranium Analyzer was modified for glovebox use. The sample cell compartment (optics block), photomultiplier tube (PMT), and photo diode are placed inside the glovebox while the rest of the instrument is mounted outside. Light from the nitrogen laser used for uranium excitation travels through two extenders (tubes), which connect from the instrument through the box wall to the optics block. Electrical connections also pass through the box wall. The modified instrument sensitivity is reduced about 25% in comparison with the standard instrument. A flow cell apparatus was constructed to transfer sample solution to and from the sample cell.

21037 (RFP—3956) **Calibration standard for metallographic microscopes.** Transue, M. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 24 Nov 1986. Contract AC04-76DP03533. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006198.
This report describes the evaluation of a diffraction grating, which can be used at magnifications of 400X or greater to establish the scale of photographs taken through a metallographic microscope.

21038 (SAND—86-1698C) **Application of a high-precision universal measuring machine in Standards Laboratory measurements.** Braudaway, D.W. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 6p. (CONF-870370—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003036.
From IEEE IMTC '87: the changing face of I and M technologies; Boston, MA, USA (27 Mar 1987).
A computer controlled high-precision Universal Measuring Machine (UMM) of advanced design has been placed in operation. Full high-accuracy operation of the machine awaits development of techniques to map and correct the machine's three-dimensional measuring space. In the meantime, the UMM is being applied to the calibration of high-precision artifacts in single- and limited two-dimensional space, aided by checks against length master reference standards. These artifacts, principally step-gages and roundness standards, require ratio type techniques similar to those employed in calibration of electrical ratio devices. The application is yielding significant time savings and accuracy enhancement. Analytical power of the machine's computer system simplifies data collection, improves computation of results, and permits deterministic checks where judgmental checks have been the practice.

21039 **New scanning transmission electron microscope microanalytical system.** Parker, N.W.; Mittleman, R.K.; Crewe, A.V. (The Enrico Fermi Institute, The University of Chicago, 5640 S. Ellis Avenue, Chicago, Illinois 60637). *Review of Scientific Instruments;* **58**: No. 2, 174-182(Feb 1987).
We have designed and built an improved, dedicated analytical scanning transmission electron microscope (STEM). A novel feature of this microscope is a magnetic lens above the accelerating gun, allowing the specimen probe to achieve very high current densities while retaining the high spatial resolution of the STEM. Integrated with this microscope, we have also implemented an image processing system which allows rapid analysis of the digitized microscope output signals. This processing system also allows the graphic simulation of planar materials (such as intercalated graphite) to derive diffraction pattern simulations for comparison with the experimental data. An image database system allows over 2000 images to be easily managed.

21040 **Simple time-resolving Thomson spectrometer.** Rhee, M.J.; Schneider, R.F.; Weidman, D.J. (Laboratory for Plasma and Fusion Energy Studies, University of Maryland, College Park, Maryland 20742). *Review of Scientific Instruments;* **58**: No. 2, 240-244(Feb 1987).
We describe a simple time-resolving Thomson spectrometer system which can provide the temporal information of ions produced by a pulsed source, in addition to the time-integrated information. The electric field in a conventional spectrometer is modulated by a time-varying field. It is shown that from the resulting spectrogram, the time-resolved quantities associated with the ions can be deduced. Experimental results with plasma focus produced ions are given as an example.

21041 **Experiments in x-ray holographic microscopy using synchrotron radiation.** Howells, M.R.; Iarocci, M.A.; Kirz, J. (National Synchrotron Light Source, Brookhaven National Laboratory, Upton, New York 11973). *Journal of the Optical Society of America A: Optics and Image Science;* **3**: No. 12, 2171-2178(Dec 1986). Contract AC02-76CH00016.

We report on experiments in x-ray holographic microscopy using a storage-ring x-ray source. Holograms of various simple objects in the size range 0.5—12 μm have been recorded by using 0.4-keV x rays and reconstructed by using a He:Cd laser (4416 A). The reconstructed image characteristics are in line with expectations concerning resolution, signal-to-noise ratio, field of view, etc. In particular, the transverse resolution in the best case was 1—2 μm, and exposure times were in the range 3—100 min.

21042 **Weak interaction studies using resonance ionization spectroscopy.** Payne, M.G.; Hurst, G.S. (Oak Ridge National Lab., TN). pp 197-202 of Analytical laser spectroscopy. Martellucci, S.; Chester, A.N. (eds.). New York, NY; Plenum Publishing Corporation (1985). Contract W-7405-ENG-26.

Important developments in laser sources for the vacuum ultraviolet (VUV) region of the spectrum are making it possible to carry out resonance ionization of some of the noble gases. It has already been shown that xenon can be ionized in a two-photon allowed excitation from the ground state. Recently a new method of generating radiation by four-wave mixing in mercury vapor enables excitation of xenon in a one-photon resonance process. With these new laser sources they expect to have effective ionization volumes of $10^{-3}$-$10^{-2}$ $cm^3$ for the cases of argon, krypton, and xenon. This has important consequences in weak interaction physics and environmental research. Widespread applications of noble gas detectors are due to the fact that small numbers of the chemically inert atoms can be recovered from very large targets of materials where they may be generated by rare events. In this lecture they show how lasers can be combined with mass spectrometers to detect a few noble gas atoms of one isotope in the presence of very large numbers of atoms of a neighboring isotope. This technique (which they have called Maxwell's demon because of the atom-sorting functions performed in the apparatus) is described and then followed with a brief discussion of two applications in weak interaction physics - double-beta decay and the solar neutrino problem.

21043 **Borrmann effect for alignment of a four-circle diffractometer.** Murphy, W.J.; Chapman, L.D.; Staudenmann, J.L.; Liedl, G.L. (Iowa State Univ., Ames). *Journal of Applied Crystallography;* **18**: 71-74(1985). Contract W-7405-ENG-82.

A very simple method is described to align accurately any full four-circle diffractometer with respect to the incident beam. This method relies on anomalous transmission measurements. It has been found that the centroids of the Ge 220 anomalous transmission intensity distributions measured at the four main positions of the / sub X/ circle, that is 0, 90, 180, and 270° not only provide an accurate determination of the reference angles for omega and phi, but also provide an accurate method to align the /sub X/ circle with respect to the direction of the incident beam. This procedure promises to be even more helpful for diffractometers installed at synchrotron radiation laboratories than for in-house installations.

21044 **Accurate wavelength determination through attenuation dips of strongly reflective crystals.** Staudenmann, J.L.; Chapman, L.D.; Murphy, W.J.; Liedl, G.L. (Iowa State Univ., Ames). *Nuclear Instruments and Methods in Physics Research;* **222**: 168-170(1984). Contract W-7405-ENG-82.

Accurate wavelength determination has been made possible by using the attentuation dips of a strongly reflecting crystal when it is rocked near a Bragg position. This transmission method has the advantage that it does not need any collimation between the sample and the detector and that it is constantly set in the line of sight; this eliminates errors due to detector misalignment. Consequently, it is more accurate than any standard Bragg measurement, because only one rotation is required; that of the crystal. Measurements between 0.36618 and 1.6782 A show that attenuation significantly shift the dip positions in pyrolitic graphite (ZYA). The authors conclude that when these effects are accounted for, any wavelength in the range mentioned above can be determined with an error of ≈ 0.1% or smaller.

21045 **High speed electronic imaging application in aeroballistic research.** Brown, R.R.; Parker, J.R. (Los Alamos National Lab., NM). *Proceedings of the Society of Photo-Optical Instrumentation Engineers;* **497**: 95-108(1984).

From High speed photography, videography, and photonics II; San Diego, CA, USA (21-22 Aug 1984).

Physical and temporal restrictions imposed by modern aeroballistics have pushed imaging technology to the point where special photoconductive surfaces and high-speed support electronics are dictated. Specifications for these devices can be formulated by a methodical analysis of critical parameters and how they interact. In terms of system theory, system transfer functions and state equations can be used in optimal coupling of devices to maximize system performance. Application of these methods to electronic imaging at the Eglin Aeroballistics Research Facility is described in this report. 7 references, 14 figures, 1 table.

# 45 EXPLOSIONS AND EXPLOSIVES

*REFER ALSO TO CITATION(S) 20939*

## 4501 Chemical

21046 **(UCID—20974) Spherical explosions and the equation of state of water.** Steinberg, D.J. (Lawrence Livermore National Lab., CA (USA)). Feb 1987. Contract W-7405-ENG-48. 10p. NTIS, PC A02/MF A01. File Number DE87006587.

We have successfully calculated an experiment in which a sphere of detonated nitromethane expands into water. The calculations are sensitive to both the nitromethane and water equations of state. For water, the most important aspect of the equation of state is the Hugoniot. 11 refs., 7 figs.

## 4502 Nuclear

*REFER ALSO TO CITATION(S) 20926*

21047 **(AD-A—175522/2/XAB) Propagation of rf signals through structured ionization. Theory and antenna-aperture-effect applications. Technical report, 1 March 1985-1 May 1986.** Dana, R.A. (Mission Research Corp., Santa Barbara, CA (USA)). 15 May 1986. 139p. (MRC-R—976). NTIS, PC A07/MF A01.

This report presents a review of the theory of propagation of RF signals through random ionospheric disturbances that would result from high-altitude chemical releases or nuclear detonations. Starting with Maxwell's equations, an analytic expression for the two-position, two-time, two-frequency mutual coherence function is derived for strong, anisotropic scattering conditions. First, the usual frozen-in approximation that models the ionosphere as a rigid structure that drifts across the line-of-sight is presented. Second, a model called the turbulent model, is developed that decouples the spatial and temporal fluctuations in the ionosphere. This model may be more accurate at times before striations have formed in the ionosphere or when multiple layers of striations with different velocities are drifting across the line-of-sight. The second part of this report presents several new results and applications of the theory. The generalized power spectral density (GPSD), which is the Fourier transform of the mutual coherence function, is used to compute the second-order statistics of the signal at the output of an anisotropic aperture antenna. Analytic results are presented for antennas with Gaussian-beam profiles, and numerical results are presented for uniformly weighted apertures. These results are then generalized to transponder communication link geometries with two independent propagation paths and four antennas.

## 4503 Explosion Detection

*REFER ALSO TO CITATION(S) 21271*

**21048 (UCRL—95351) A master event strategy for location with seismic array data.** Harris, D.B. (Lawrence Livermore National Lab., CA (USA)). Dec 1986. Contract W-7405-ENG-48. 5p. (CONF-870470—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003464.

From IEEE conference on acoustics, speech and signal processing; Dallas, TX, USA (6 Apr 1987).

Refraction, scattering and multipath are often severe in regional seismic array data. An example from the NORESS array in southeastern Norway shows the extent of the problem and illustrates the ambiguities in event location that can result from FK analysis. The location estimation problem might be recast as a multiple hypothesis test on location in regions which are characterized by a moderate number of discrete repeating sources. Unlocated events are correlated against calibrating "master" events for these source locations. The best match identifies the origins of the unlocated events. An example establishes the plausibility of the method.

# 50 ENVIRONMENTAL SCIENCES, ATMOSPHERIC

**21049 Northern Hemisphere wintertime variability in a two-level general circulation model. Part I: Statistical characteristics of short and long time-scale disturbances.** Kushnir, Y.; Esbensen, S.K. (Climatic Research Institute and Department of Atmospheric Sciences, Oregon State University). *Journal of the Atmospheric Sciences;* **43**: No. 23, 2968-2984(1 Dec 1986).

The properties of atmospheric Northern Hemisphere wintertime variability, simulated by the Oregon State University two-level general circulation model are examined. Time series of the dependent variables and diabatic heating components are extracted from ten simulated Northern hemisphere winters. Variance and covariance analyses are performed to determine the geographical distribution of the intensities and transport properties of eddies of high-frequency (periods between 2.5 and 10 days) and low-frequency (periods between 10 days and a season).

**21050 Northern Hemisphere wintertime variability in a two-level general circulation model. Part II. The maintenance of short and long time-scale disturbances.** Kushnir, Y.; Esbensen, S.K. (Climatic Research Institute and Department of Atmospheric Sciences, Oregon State University, Corvallis, OR 97331). *Journal of the Atmospheric Sciences;* **43**: No. 23, 2985-2998(1 Dec 1986).

The energetics of large-scale disturbances of the wintertime, Northern Hemisphere circulation are studied with the OSU two-level general circulation model. The behavior of simulated eddies with short time-scale (2.5 to 10 days) is found to be consistent with observations and with baroclinic instability theory. Eddies with long time-scales (>10 days) appear to be maintained primarily by high-latitude baroclinic energy conversions. Energy conversions characteristic of barotropic processes are found at jet stream latitudes.

**21051 Relationship between decreased temperature range and precipitation trends in the United States and Canada, 1941—80.** Karl, T.R.; Kukla, G.; Gavin, J. (National Climatic Data Center, NESDIS, NOAA, Asheville, NC 28801). *Journal of Applied Meteorology;* **25**: No. 12, 1878-1886(Dec 1986).

Previous work has shown significant decreases of the diurnal temperature range (1941—80) across a network of 130 stations in the United States and Canada. In the present study, changes in monthly total precipitation at these same stations were related to the decrease in temperature range using various Monte Carlo tests. These tests indicate that factors other than those related to precipitation contributed to the decrease of daily temperature range. Further study of the mechanisms responsible for the decreased temperature range is warranted, based on these results. The decreased range may be one of the few pieces of evidence available in North America that is consistent with potential impacts of increased greenhouse gases and/or anthropogenic aerosols.

## 5001 Basic Studies

*REFER ALSO TO CITATION(S) 21113*

**21052 (DFVLR-FB—86-51) Investigations on the entropy of cloudy air.** Hauf, T.; Weidner, J. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Koeln (Germany, F.R.); Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Oberpfaffenhofen (Germany, F.R.). Inst. fuer Physik der Atmosphaere). 21 Nov 1986. 152p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87751617.

The entropy state function is derived for the atmospheric physical system of cloudy air. The dependence of entropy on pressure p, temperature T, and concentrations m/sup k/ is discussed in detail. For reasons of understanding and illustration the statistical interpretation of entropy is considered. The entropy budget is studied extensively. Some problems related to the use of entropy as a prognostic quantity in a numerical fluid dynamical model are studied and their solutions are suggested. With 10 figs., 14 refs.

**21053 (EIR—604) Experimental investigation of atmospheric dispersion over complex terrain in a prealpine region (experiment SIESTA).** Gassmann, F.; Gaglione, P.; Hasenjaeger, H.; Gryning, S.E.; Lyck, E.; Richner, H.; Neininger, B.; Vogt, S.; Thomas, P. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland); Commission of the European Communities, Ispra (Italy). Joint Research Centre; Risoe National Lab., Roskilde (Denmark); Eidgenoessische Technische Hochschule, Zurich (Switzerland). Lab. fuer Atmosphaerenphysik; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.)). Oct 1986. 137p. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751619.

The original aim of the project was to obtain knowledge of the general nature of the turbulence, advection and atmospheric dispersion in a cold pool with very weak wind and undefined wind direction, whence the name SIESTA = SF/sub 6/ International Experiments in Stagnant Air. The aim had to be modified: Instead of an investigation of stagnant situations with undefined wind direction, the two flow regimes parallel to the Jura ridge were investigated, which represent the most frequent wind systems occurring on the Swiss Plain. Whereas convective situations are understood quite well, there are important lacks of knowledge for neutral and stable situations especially over complex terrain, where drainage flows occur. During the 6 experiments, neutral or slightly stable situations were found with vertical heat-flux below 10-20 W/m/sup 2/ and almost adiabatic lapse rates below 100-200 m above ground level. So, the 6 experiments including SF/sub 6/-tracer measurements, radar-tracked constant level balloons and micrometeorological measurements will give deeper physical insight in the diffusion and transport processes during near neutral situations over complex terrain in the mesoscale range (up to 90 km). The extensive data set will be concentrated in a data bank for free use for interested persons or organizations.

**21054 (RFP—3915) Feasibility study of silver iodide smoke as an atmospheric dispersion tracer for Rocky Flats Plant site, July 1983-December 1984.** Langer, G. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 22 Sep 1986. Contract AC04-76DP03533. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005793.

At Rocky Flats Plant, we developed a technique that employs the release of silver iodide (AgI) smoke as a very economical tracer for air dispersion around the Plant. In an emergency, the AgI smoke would trace a contaminant plume over long distances, in real time, to guide emergency response. To test this technique, we experimented with first releasing AgI smoke particles, then tracking them up to 50 km from the Plant by vehicle and aircraft under various typical weather conditions. Able to detect single AgI particles as small as 0.01 μm in real time, a portable cloud chamber operated on either a pickup truck or a small aircraft. For both pro-

cedures, a simple smoke generator operating unattended produced up to 1 x $10^{15}$ particles/g of AgI. Ground tracking of the smoke (1) showed the influence on dispersion by the midday shift from downslope to upslope flow during stable conditions and (2) provided an interesting case study of a nearby thunderstorm as a transient effect. Aerial tracking during eight flights covered a wide range of meteorological conditions. Convective flow often lofted the smoke completely off the ground before it left the Plant boundary. During inversion conditions, the tracer remained within 100 m of the ground.

21055 **Further note on the Kolmogorov-von Karman product and the values of the constants.** Frenzen, P.; Hart, R.L. (Argonne National Lab., IL). pp 24-27 of Sixth symposium on turbulence and diffusion. Boston, MA; American Meteorological Society (1983).

From 6. symposium on turbulence and diffusion; Boston, MA, USA (22-25 Mar 1983).

New estimates of the Kolmogorov and von Karman constants, $\alpha_1$ and k, have recently been reported by Dyer and Bradley (1982) and by Dyer and Hicks (1982). These values, based on data originally recorded for other purposes during the International Turbulence Comparison Experiment held in Australia in 1976, imply a magnitude of the Kolmogorov-von Karman product, $\alpha_1$k/sup 4/3/, somewhat at variance with that measured by a special add-on experiment conducted over the same site only a few days after the ITCE-76 program had been completed. These last results are presented here in combination with earlier data collected in a similar experiment carried out in 1968. Both data sets are summarized in a form which provides an improved value of the K-von K product. In part, this not explains results listed with little comment in a paper on a related topic which appeared in an earlier Turbulence Symposium Preprint Volume (Frenzen, 1979: p. 11, Table 2).

## 5002 Chemicals Monitoring And Transport

*REFER ALSO TO CITATION(S) 19917, 19919, 19924, 19926, 19990, 20451, 20459, 20493, 20513, 21230, 21231*

21056 **(AD-A—175173/4/XAB) AFGL (Air Force Geophysical Laboratory) atmospheric constituent profiles (0.120km). Environmental research papers.** Anderson, G.P.; Clough, S.A.; Kneizys, F.X.; Chetwynd, J.H.; Shettle, E.P. (Air Force Geophysics Lab., Hanscom AFB, MA (USA)). 15 May 1986. 46p. (AFGL-TR—86-0110). NTIS, PC A03/MF A01.

An atmospheric data base consisting of volume-mixing ratios (o0 to 12 okm) for 28 minor and trace gases was assembled for use with spectral-radiance transmittance models. Six reference atmospheres, each defining temperature, pressure and density as a function of altitude (selected from the U.S. Standard Supplements, 1966 and the U.S. Standard Atmosphere, 1976) provide a range of climatological choices. Analogous zonal-mean descriptions for $H_2O$, $O_3$, $N_2O$, CO, and $CH_4$ were subsequently adapted from satellite data and/or dynamical-photochemical analyses. The remaining species are defined by single profiles, usually appropriate for U.S. Standard conditions. Because the entire profile set is preferentially based on available measurements, explicit photochemical consistency between the different species has not been maintained.

21057 **(AD-A—175337/5/XAB) Nature of airborne particulates at tropic exposure sites. Final report, November 1982-September 1984.** Chen, F.; Dement, W.A. (Army Tropic Test Center, APO Miami 34004 (USA)). Sep 1984. 59p. (USATTC—840903). NTIS, PC A04/MF A01.

Airborne particulates were collected at five exposure sites in Panama using cascade impactor air samplers. Scanning electron microscopy, energy dispersive x-ray analysis, and culture identification techniques were used to analyze the particulates. Analysis revealed that the particulates consist of silicates, chlorides, and sulfur-rich and phosphorus-rich particles. Atmospheric particle levels were higher in the dry season than in the rainy season, and the predominant fungal species varied at each exposure site. The open direct exposure of culture plates served as a simple, appropriate method for monitoring atmospheric fungal spores.

21058 **(AD-A—175410/0/XAB) Behavior of smokes and agents during variable meteorological conditions over complex terrain. Final report, 15 November 1982-31 May 1986.** Ludwig, F.L. (SRI International, Menlo Park, CA (USA)). Sep 1986. 119p. NTIS, PC A06/MF A01.

A program was undertaken to develop a system of models for describing transport and diffusion of smokes and agents in complex terrain under time-varying meteorological conditions. The ulitmate goal is to provide the probabilities for observing concentration(point or path-integrated) above a specified threshold. Lidar cross sections through smoke plumes were analyzed and a preliminary mehtod for estimating the likelihood of finding a clear path through the plume is discussed. The literature was reviewed to find a framework for generating the required small-scale concentration distribution. The concept of fractal dimension is shown to have considerable promise. An extensive literature review and bibliography on the subject of scaling, fractal dimension, and applications to atmospheric processes is included as an appendix. The report describes the research necessary to apply the identified concepts and to complete the desired system of models.

21059 **(CEA-CONF—8693) Study of a detector made of Langmuir-Blodgett layers: reactivity to NO/sub x/.** Henrion, L.; Derost, G.; Ruaudel-Teixier, A.; Barraud, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). 1986. 16p. (In French). (CONF-8609258—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751681.

From Congress of the Societe Francaise de Chimie; Paris, France (8 Sep 1986).

Films of n-docosyl pyridinium, TCNQ are obtained by the Langmuir-Blodgett method. A semi-quantitative study of the action of NO/sub x/ vapors on the film is presented. The film is doped by NO/sub x/ vapors and becomes conductor with a resistivity of about 10/sup 2/ ohms.cm. For lower concentration, NO/sub x/ vapors give an oxidation complex characterized by an optical absorption at 480 nm and films are dielectric. For higher concentration NO/sub x/ vapor oxidize completely TCNQ/sup -/. Excess of TCNQ degree is characterized by an optical absorption at 436 nm and films are dielectric or highly resistant.

21060 **(CEA-R—5365) Study of turbulence induced by sound waves.** Malherbe, C. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Protection et de Surete Nucleaire). Aug 1986. 80p. (In French). NTIS (US Sales Only), PC A05/MF A01. File Number DE87750989.

The efficiency of sonic coagulation and precipitation of particles in an acoustic field is strongly reinforced above the acoustic intensity threshold corresponding to the appearance of acoustic turbulence. The aim of this work is to evaluate the turbulence properties of the experimental system in order to calculate acoustic agglomeration and precipation kernels. A study of the aerodynamic behaviour of the fluid has shown the presence of turbulence in the system. Then, turbulence spectra have been measured in order to foresee the turbulence evolution (the largest structures degenerate in small eddies; inside them sonic coagulation occurs). Finally, the energy dissipated into heat in the system - a parameter representative of turbulence - has been evaluated.

21061 **(CONF-870323—2) Results for $SO_2$ and NO/sub x/ removal from flue gas by a moving bed of copper oxide.** Stelman, D.; Ampaya, J.P.; Newcomb, J.C. (Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.). 1987. Contract AC22-83PC60262. 48p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87005396.

From American Institute of Chemical Engineers spring national meeting; Houston, TX, USA (29 Mar 1987).

A single-stage process for simultaneously removing 90% of the NO/sub x/ and $SO_2$ and 99.9% of the particulate material from coal-fired flue gas will be reported. The process utilizes a novel contactor/filter with a moving bed of copper oxide absorber-catalyst.

21062 **(CONF-870416—2) Acid deposition and forest nutrient cycling.** Johnson, D.W. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005694.

From 14. annual energy technology conference and exposition; Washington, DC, USA (14 Apr 1987).

This paper briefly reviews some of the highlights in the rapidly expanding literature on this acid deposition. The reader is referred to the references cited above for more detailed discussions. Most of the papers reviewed here were concerned with the effects of atmospheric deposition on one or more of the nutrient cycling processes depicted in Figure 1. This figure will serve as a format for the following discussion in that we first review studies relating to deposition and canopy interactions, then to decomposition and nutrient mineralization, uptake, leaching, and weathering, noting gaps in knowledge as we proceed through the cycle, and hopefully placing the results of these various process-level studies into an ecosystem-level, nutrient cycling perspective.

21063 **(DOE/ER/60350—2) Geophysical models of the fossil fuel CO/sub 2/ problem: [Annual progress report, February 1986-February 1987].** Hoffert, M.I. (New York Univ., NY (USA). Dept. of Applied Science). Feb 1987. Contract FG02-85ER60350. 19p. NTIS, PC A02. File Number DE87006362.

Research this past year included studies of the role of ocean mixing on oceanic heat and mass transfer, projections of global sea level rise effects, the role of solar variability on past and future global temperature records, and the development of coupled two-dimensional atmosphere/ocean climate models to predict the global warming from fossil fuel $CO_2$. We also began developing a new energy balance model with seasonal resolution incorporating a simple sea ice and oceanic poleward heatflux parameterizations specifically oriented toward long-term integrations of coupled two-dimensional atmosphere/ocean climate models. Such models could also be used to study the possible role of $CO_2$ gas exchange with the oceans during astronomically-triggered glaciations and de-glaciations - a potential climatic feedback with important implications for anthropogenically-triggered $CO_2$ climate change as well.

21064 **(LBL—22663) Process studies for a new method of removing $H_2S$ from industrial gas streams.** Neumann, D.W.; Lynn, S. (Lawrence Berkeley Lab., CA (USA)). Jul 1986. Contract AC03-76SF00098. 285p. NTIS, PC A13/MF A01; 1; GPO Dep. File Number DE87006140.

A process for the removal of hydrogen sulfide from coal-derived gas streams has been developed. The basis for the process is the absorption of $H_2S$ into a polar organic solvent where it is reacted with dissolved sulfur dioxide to form elemental sulfur. After sulfur is crystallized from solution, the solvent is stripped to remove dissolved gases and water formed by the reaction. The $SO_2$ is generated by burning a portion of the sulfur in a furnace where the heat of combustion is used to generate high pressure steam. The $SO_2$ is absorbed into part of the lean solvent to form the solution necessary for the first step. The kinetics of the reaction between $H_2S$ and $SO_2$ dissolved in mixtures of N,N-Dimethylaniline (DMA)/ Diethylene Glycol Monomethyl Ether and DMA/Triethylene Glycol Dimethyl Ether was studied by following the temperature rise in an adiabatic calorimeter. This irreversible reaction was found to be first-order in both $H_2S$ and $SO_2$, with an approximates heat of reaction of 28 kcal/mole of $SO_2$. The sole products of the reaction appear to be elemental sulfur and water. The presence of DMA increases the value of the second-order rate constant by an order of magnitude over that obtained in the glycol ethers alone. Addition of other tertiary aromatic amines enhances the observed kinetics; heterocyclic amines (e.g., pyridine derivatives) have been found to be 10 to 100 times more effective as catalysts when compared to DMA.

21065 **(NP—7770070) Cadmium pollution caused by Cd-emissions from an industrial plant.** Fischbach, H. (Technische Hochschule Aachen (Germany, F.R.). Medizinische Fakultaet). 15 Mar 1985. 92p. (In German). NTIS (US Sales Only), PC A05/MF A01. File Number DE87770070.

In this paper a cadmium-emitting factory is used as an example to demonstrate in how far cadmium processing industries contribute to environmental pollution and how measures of environmental protection can be integrated in application technology. The summary shows to what extent cadmium immissions can upset the ecological balance, the central issue being whether the maximum values on the various fields can be concerned or whether medical and ecological considerations demand new standards to be set.

21066 **(PB—87-125704/XAB) Removal of sulfur dioxide from a simulated museum atmosphere using carbon filters.** Gibbens, H.R.; Pope, D.; Moss, R.L. (Warren Spring Lab., Stevenage (UK)). 1985. 21p. (LR—525(AP)M). NTIS, PC PC E04/MF E04.

Investigations were carried out on the removal of sulfur dioxide from a room representing a small gallery, or store, in a museum using a mobile air-conditioning unit incorporating an activated carbon filter. The test space was artificially ventilated at a rate equivalent to one air change per hour with air containing sufficient sulfur dioxide to simulate winter conditions in London, namely a concentration of 100 microgram/$m^3$ or 35 parts per billion (ppb). Temperature and relative humidity has a considerable effect on the concentration of sulfur dioxide present in the atmosphere of the test room, and up to two thirds of the $SO_2$ introduced was adsorbed on the surfaces of the building.

21067 **(PB—87-125779/XAB) National Air Toxics Information Clearinghouse: NATICH data base report on state and local agency air toxics activities, July 1986. Volumes 1 and 2. Interim report.** (Radian Corp., Austin, TX (USA)). Jul 1986. 862p. (RAD—86-239-001-01-08). NTIS, PC A99/MF E04.

Supersedes PB—86-200466.

The purpose of the report is to disseminate information provided to the NATICH data base by State and local air agencies on their air-toxics activities. The computer-generated report supersedes manually- and computer-prepared interim reports published in September 1984, March 1985, and September 1985. It both updates and extends (in new tables) the information in the first three reports and contains information received through April 1986. The report includes a listing of State and local agencies that have provided information to the Clearinghouse, air toxics contacts, acceptable ambient concentrations and standards and the basis for those concentrations/standards; and information on regulatory programs, pollutant research, methods development activities, permitting, source testing, ambient monitoring, emissions inventory, risk assessment, and State/local bibliographies.

21068 **(PB—87-125977/XAB) Development of air sampling and analytical methods for toxic chlorinated organic compounds: research report for p-chlorophenol.** (Southern Research Inst., Birmingham, AL (USA)). 19 Sep 1980. 67p. (SORI-EAS—80-589). NTIS, PC A04/MF A01.

A sampling and analytical method for the determination of p-chlorophenol in air was developed. The compound was collected from the air with a solid sorbent, silica gel, desorbed with acetonitrile and analyzed by high-performance liquid chromatography with ultraviolet absorption spectrophotometric detection. Over a range of 0.91 to 23 milligrams per cubic meter, the average bias of the sampling method was minus 2% with a pooled relative standard deviation of 6.1%.

21069 **(PB—87-125985/XAB) Development of a model for the identification of high risk occupational groups using RTECS (Registry of Toxic Effects of Chemical Substances) and NOHS (National Occupational Hazard Survey) data. Final report.** Pielmeier, G.R. (Tracor JITCO, Inc., Rockville, MD (USA)). Mar 1981. 132p. NTIS, PC A07/MF A01.

In September of 1984, the USEPA informed the State that the State Implementation Plan (SIP) for sulfur dioxide in Madison County was inadequate. The report documents the results of analyses of sulfur dioxide air quality in the Alton-Wood River area and represents the most detailed and thorough study performed to date by the IEPA for Madison County. The study results form a basis for additional emission controls for a source in the study area. These additional controls are necessary in order to assure compliance with air-quality standards for sulfur dioxide.

21070 **(PB—87-126645/XAB) Supercritical fluid chromatography of polar organic compounds in combustion particulates. Progress report, 28 September 1984-28 December 1985.** (Brigham Young Univ., Provo, UT (USA). Dept. of Chemistry). 31 Mar 1986. 52p. NTIS, PC A04/MF A01.

A thermionic detector was evaluated for capillary supercritical fluid chromatography of polar nitro-containing polycyclic aromatic compounds (nitro-PAC). Three modes of detector operation were studied. The best performance was obtained using a nitro-selective mode of detection. Although linearity was confined to a narrow range for a given source current, the sensitivity was excellent; 20 pg injected for p-nitrophenol gave a signal-to-noise ratio of 3. Conventional thermionic detection also produced good sensitivity; however, serious baseline drift was observed at high operating temperatures using density programming. A third mode, flame thermionic detection, was not acceptable because of low sensitivity. A number of nitro-PAC were successfully chromatographed using density programming at 101°C.

21071 **(PB—87-126934/XAB) Development of air sampling and analytical methods for toxic chlorinated organic compounds: research report for hexachlorobutadiene.** Dillon, H.K. (Southern Research Inst., Birmingham, AL (USA)). 21 Dec 1979. 62p. (SORI-EAS—79-658). NTIS, PC A04/MF A01.

An air sampling and analytical method for the determination of hexachlorobutadiene (HCBD) in air was developed. HCBD was collected from air with a solid sorbent and desorbed with hexane. A known volume of air was drawn through an Amberlite XAD-2 tube to trap HCBD vapor. The analyte was desorbed from the sorbent with hexane and an aliquot of the resulting solution was analyzed using a gas chromatograph equipped for electron-capture detection. The front and rear sections of the sorbent tube were analyzed separately; the rear section was used as a breakthrough indicator. The method was partially tested using sample loadings of 4 to 3000 nanograms per sorbent tube for the supporting analytical method. The complete method was tested with air containing approximately 10 to 2000 micrograms per cubic meter of HCBD at temperatures of 25 to 28°C at a relative humidity of over 90%. The method was tested and modified until valid results were obtained.

21072 **(PB—87-127551/XAB) Method for evaluation of atmospheric vapor concentrations emitted by instantaneous or continuous sources. Technical note.** Pelletier, R.; Dekoninck, A. (Etablissement Technique Central de l'Armement, Arcueil (France). Centre d'Études du Bouchet). 7 Jul 1986. 38p. (In French). (NT—24/X/AE). NTIS, PC PC E04/MF E04.

Doury's method for determining vapor concentrations and Ct's (expansion unknown) emitted into the atmosphere by instantaneous or continuous sources was adapted for microcomputers (Apple II). The method allows acceptable levels of these concentrations and Ct's to be rapidly calculated. Moreover, by adding a spherical model, it takes into consideration the source's volume.

21073 **(PB—87-127601/XAB) Port Vessel Emissions Model: a computer model for calculating vessel air pollutants (for microcomputers). Model.** Knatz, G.; Hayden, P.; Buck, B.; Arnold, B. (Maritime Administration, Washington, DC (USA). Office of Port and Intermodel Development). Dec 1986. vp. NTIS CP T99.

The software is contained on 5 1/4-inch diskette, double sided, double density compatible with the IBM-PC microcomputer. Diskettes are in the ASCII format. Price includes documentation, PB—87-127619, PB—87-127627, and PB—87-127635.

Port Vessel Emissions Model (PVEM) is a computer program that calculates air pollutant emissions associated with vessel activity in ports for various operational scenarios. PVEM can easily be adapted for application to any port through the use of port-specific input data on vessel movements and berth pathways...Software Description: The program was developed for implementation on an IBM-PC or MS-DOS microcomputer equipped with 300K RAM.

21074 **(PB—87-127619/XAB) Port Vessel Emissions Model: a computer model for calculating vessel air pollutants. Volume 1. Study report. Final report, October 1984-December 1986.** Knatz, G.; Hayden, P.; Buck, B.; Arnold, B. (Port of Long Beach, CA (USA)). Dec 1986. 122p. NTIS, PC A06/MF A01.

For system on diskette, see PB—87-127601.

Port Vessel Emissions Model (PVEM) is a computer program that calculates air-pollutant emissions associated with vessel activity in ports for various operational scenarios. PVEM was developed for implementation on an IBM-PC or MS-DOS microcomputer equipped with 300K of available Random Access Memory. PVEM calculates fuel combustion-related pollutant emissions from marine engines resulting from vessel cruising, transit, maneuvering, hotelling, tug, assistance and recreational vessel usage. PVEM also calculates hydrocarbons released to the atmosphere during liquid bulk loading/offloading, ballasting, lightering and bunkering. Pollutants calculated are nitrogen oxides (NOx), total hydrocarbons (THC), carbon monoxide (CO), sulfur dioxide ($SO_2$), and particulate matter (PM). PVEM can easily be adapted for application to any port through the use of port-specific input data on vessel movements and berth pathways. Documentation consists of 3 volumes. Volume I, the Study Report, is an overview of model development with model examples based on the Ports of Long Beach and Portland.

21075 **(PB—87-127627/XAB) Port Vessel Emissions Model: a computer model for calculating vessel air pollutants. Volume 2. User's manual. Final report, October 1984-December 1986.** Knatz, G.; Hayden, P.; Buck, B.; Arnold, B. (Port of Long Beach, CA (USA)). Dec 1986. 430p. NTIS, PC A19/MF A01.

For system on diskette, see PB—87-127601; See also PB—87-127619, and PB—87-127635.

Port Vessel Emissions Model (PVEM) is a computer program that calculates air-pollutant emissions associated with vessel activity in ports for various operational scenarios. PVEM was developed for implementation on an IBM-PC or MS-DOS microcomputer equipped with 300K of available Random Access Memory. PVEM calculates fuel combustion-related pollutant emissions from marine engines resulting from vessel cruising, transit, maneuvering, hotelling, tug assistance, and recreational-vessel usage. PVEM also calculates hydrocarbons released to the atmosphere during liquid bulk loading/offloading, ballasting, lightering, and bunkering. Pollutants calculated are nitrogen oxides (NOx), total hydrocarbons (THC), carbon monoxide (CO), sulfur dioxide ($SO_2$), and particulate matter (PM). PVEM can easily be adapted for application to any port through the use of port-specific input data on vessel movements and berth pathways. Volume II, the User's Manual, is a guide to the use of PVEM software and a technical description of the model. Volume III, the Workbook, is a manual method for calculating vessel emissions without the use of a microcomputer.

21076 **(PB—87-127635/XAB) Port Vessel Emissions Model: a computer model for calculating vessel air pollutants. Volume 3. Workbook. Final report, October 1984-December 1986.** Knatz, G.; Hayden, P.; Buck, B.; Arnold, B. (Port of Long Beach, CA (USA)). Dec 1986. 63p. NTIS, PC A04/MF A01.

For system on diskette, see PB—87-127601; See also PB—87-127627.

Port Vessel Emissions Model (PVEM) is a computer program that calculates air-pollutant emissions associated with vessel activity in ports for various operational scenarios. PVEM was developed for implementation on an IBM-PC or MS-DOS microcomputer equipped with 300K of available Random Access Memory. PVEM calculates fuel combustion-related pollutant emissions from marine engines resulting from vessel cruising, transit, maneuvering, hotelling, tug assistance, and recreational-vessel usage. PVEM also calculates hydrocarbons released to the atmosphere during liquid bulk loading/offloading, ballasting, lightering, and bunkering. Pollutants calculated are nitrogen oxides (NOx), total hydrocarbons (THC), carbon monoxide (CO), sulfur dioxide ($SO_2$), and particulate matter (PM). PVEM can easily be adapted for application to any port through the use of port-specific input data on vessel movements and berth pathways. Volume III, the Workbook, is a

manual method for calculating vessel emissions without the use of a microcomputer.

21077 **(PB—87-127759/XAB) Integrated Air Pollution Control System design and cost-estimating model Version 2 (IAPCS2). User's manual. Volume 2. Appendix C.** Palmisano, P.J.; Laseke, B.A. (PEI Associates, Inc., Cincinnati, OH (USA)). Sep 1986. 336p. NTIS, PC A15/MF A01.

For system on diskette, see PB—87-127775; See also PB—87-127767.

The manual describes and is a guide to the user of Version II of the Integrated Air Pollution Control System (IAPCS-II), a computerized-simulation model for estimating the costs and predicting the performance of sulfur dioxide, nitrogen oxides, and particulate matter control systems for coal-fired utility boilers. It gives the design bases of the modules comprising the model and the structure of the program itself, as well as the bases for a number of model enhancements available to the user. The model includes conventional and emrging technologies that effect pre-in-situ, and post-combustion emission control. The model can accept any combination of the technology modules built into the system. Interactions are reflected in a material-balance tabulation of the exit of each module. Alterations in the material balance are used to account for integrated performance and cost effects. The emission-control technologies contained in IAPCS-II can be selected in either isolated or integrated configurations. IAPCS-II incorporates a number of enhancements to the design premises of the emission-control modules, as well as the model's user access and versatility.

21078 **(PB—87-127767/XAB) Integrated Air Pollution Control System design and cost-estimating model Version 2 (IAPCS2). user's manual. Volume 1.** Palmisano, P.J.; Laseke, B.A. (PEI Associates, Inc., Cincinnati, OH (USA)). Sep 1986. 132p. NTIS, PC A07/MF A01.

For system on diskette, see PB—87-127775; See also PB—87-127759.

The manual describes and is a guide to the user of Version II of the Integrated Air Pollution Control System (IAPCS-II), a computerized-simulation model for estimating the costs and predicting the performance of sulfur dioxide, nitrogen oxides, and particulate matter control systems for coal-fired utility boilers. It gives the design bases of the modules comprising the model and the structure of the program itself, as well as the bases for a number of model enhancements available to the user. The model includes conventional and emerging technologies that effect pre-in-situ, and post-combustion emission control. The model can accept any combination of the technology modules built into the system. Interactions are reflected in a material-balance tabulation of the exit of each module. Alterations in the material balance are used to account for integrated performance and cost effects. The emission control technologies contained in IAPCS-II can be selected in either isolated or integrated configurations. IAPCS-II incorporates a number of enhancements to the design premises of the emission-control modules, as well as the model's user access and versatility.

21079 **(PB—87-127775/XAB) Integrated Air Pollution Control System cost model Version 2 (IAPCS2) (for microcomputers). Model.** Kaplan, N.; Palmisano, J. (Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab.). Aug 1986. vp. NTIS CP T99.

The software is contained on 5 1/2-inch diskette, double sided, double density compatible with the IBM PC AT microcomputer. Diskettes are in the ASCII format. Price includes documentation, PB87-127767, and PB87-127759.

The Integrated Air Pollution Control System (IAPCS) is a computerized simulation model developed for EPA's Air and Energy Engineering Research Laboratory (AEERL) to estimate the costs and predict the performance of sulfur dioxide ($SO_2$), nitrogen oxides (NOx), and particulate matter (PM) emission-control systems for coal-fired utility boilers. The model includes conventional and emerging technologies that effect pre-, in-situ, and post-combustion emission control. The model can accept any combination of the technology modules built into the system. Alterations in the material balance are used to account for integrated performance and cost effects. The emission-control technologies contained in IAPCS can be selected in either isolated or integrated configurations. The power of IAPCS lies in its ability to reflect integrated effects of various control configurations. This allows the analyst to identify synergistic interactions and thus optimize performance and cost in terms of integrated cost effectiveness. Software Description: The program is written in the Fortran programming language for implementation on an IBM-PC AT or compatible microcomputer using the PC-DOS operating system. 512K bytes of core storage required. 1.5 Mbytes hard disk space; 80287 recommended.

21080 **(PB—87-129524/XAB) Pilot study of sampling and analysis for polynuclear aromatic compounds in indoor air. Report for 1 February-30 September 1984.** Chuang, J.C.; Mack, G.A.; Koetz, J.R.; Petersen, B.A. (Battelle Columbus Div., OH (USA)). Dec 1986. 223p. NTIS, PC A10/MF A01.

The report presents the results of a nine-home indoor-air study that the authors performed in Columbus, Ohio in the winter of 1984. The main objective of the study was the field evaluation of sampling and analysis methodology. However, several additional results of the study are interesting and useful, including the finding of polynuclear aromatic hydrocarbons (PAH) at levels from 0.000 to 143 ng/cu m in residences, strong correlations of these levels with smoking by occupants, little influence of fireplace use on the PAH levels, the identification of quinoline as a potential marker for cigarette smoking, and measurement of 2- and 3-nitrofluoranthene, which are potent mutagens, at significant levels from 0.000 to 0.185 ng/cu m, also correlated with smoking.

21081 **(PB—87-129540/XAB) Phase distributions of low-volatility organics in ambient air.** Cantrell, B.K.; Salas, L.J.; Johnson, W.B.; Harper, J.C. (SRI International, Menlo Park, CA (USA)). Dec 1986. 80p. NTIS, PC A05/MF A01.

Current strategies to control photochemical air pollution rely on abating the emission of volatile organic compounds. Primarily, these compounds exist in the vapor phase, and are those with a carbon number of ten or less. Recent attention has been given to low-volatility organic compounds (LVO) which may be partitioned between the gas and aerosol phases, and may only partially participate in smog formation. A three-part study was conducted to determine the role of such LVO's. First, a comprehensive review was made of the existing literature on atmospheric LVO to evaluate existing data and the measurement techniques used to collect the data. Second, an effort was made to develop an estimator for the phase distribution of LVO's in the atmosphere. The concurrent third part of the study involved an attempt to develop and test an improved and reliable collection and analysis technique for LVO. An effective denuder device was developed that can be used to provide a sample of the aerosol fraction of LVO under laboratory conditions.

21082 **(PB—87-129763/XAB) Siting criteria for regionally located-wet deposition collection sites.** Eaton, W.C.; Tew, E.L. (Research Triangle Inst., Research Triangle Park, NC (USA)). Dec 1986. 9p. NTIS, PC A02/MF A01.

The report provides a listing of siting criteria that can be used in selecting sites for wet deposition measurements in rural areas. The criteria are grouped into three categories that address influences on the sample collection from the point of view of (1) nearby site influences, (2) local influences, and (3) regional influences.

21083 **(PB—87-129805/XAB) Evaluation of an EPA (Environmental Protection Agency) high-volume air sampler for polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans.** DeRoos, F.L.; Tabor, J.E.; Miller, S.E.; Watson, S.C.; Hatchel, J.A. (Battelle Columbus Div., OH (USA)). Dec 1986. 36p. NTIS, PC A03/MF A01.

A high-volume air sampler was evaluated for collection of polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF). The sampler consists of a filter, polyurethane foam adsorbent cartridge, air pump, and environmental housing. The use of an alternative adsorbent, silica gel, was also studied. The study was carried out using 1,2,3,4-tetra-chlorodibenzo-p-dioxin, 1,2,4,8-tetrachlorodibenzofuran, 1,2,3,4,7,8-hexachlorodibenzo-p-dioxin, 1,2,3,6,7,8-hexachlorodibenzofuran, octachlorodibenzo-p-dioxin, and octachlorodibenzofuran. The overall average retention

efficiency for all of the isomers at two concentration levels was 99% for both the PUF and the silica gel adsorbents. The desorption efficiency of the PCDD/PCDF isomers from spiked filters was evaluated to assess the extent of migration of these compounds from the filter to the adsorbent. Migration was dependent upon the isomers' chlorination level with the less-chlorinated, more-volatile isomers generally desorbing more efficiently.

21084 **(PB—87-129979/XAB) Comparison of polyurethane foam and XAD-2 resin as collection media for polynuclear aromatic hydrocarbons in air. Report for 1 August 1985-31 May 1986.** Chuang, J.C.; Hannan, S.W.; Koetz, J.R. (Battelle Columbus Div., OH (USA)). Dec 1986. 35p. NTIS, PC A03/MF A01.

The objective of the project was to evaluate the collection and retention efficiency for polynuclear aromatic hydrocarbon (PAH) adsorbed or spiked on polyurethane (PUF) and XAD-2 cartridges, and to compare the effect of sampling temperature on retention efficiency for PAH spiked on PUF and XAD-2 resin cartridges. It appeared that XAD-2 resin has better collection efficiency for volatile 2-ring PAH than does the PUF. In addition, some spiked volatile and reactive PAH were well retained on XAD-2 resin, whereas only a small portion of these compounds is retained on PUF after exposure to ambient air at a 6.7 cfm flow rate for 24 hours. The retention efficiency for volatile PAH can be improved by lowering sampling temperature. However, the retention efficiency for reactive PAH such as cyclopenta(c,d) pyrene cannot be improved at lower sampling temperature. The losses of cyclopenta(c,d)pyrene are not through volatilization but are due to the reactivity of the compound.

21085 **(PB—87-130274/XAB) Report for non-flame hazardous-waste thermal destruction. Final report, January 1985-July 1986.** Malanchuk, M. (Environmental Protection Agency, Cincinnati, OH (USA). Hazardous Waste Engineering Research Lab.). Dec 1986. 44p. (EPA—600/2-86/105). NTIS, PC A03/MF A01.

A laboratory apparatus, identified as the Thermal Decomposition Unit-Gas Chromatograph (TDU-GC) system, was used to investigate the impact of key factors of the post-flame zone in the combustion process upon the effluent decomposition products. The results from thermal treatment of various organic compounds showed that: (1) Very good reproducibility under similar test conditions was obtained for effluent composition/concentration from initial thermal treatment tests, of a solid, pentachloronitrobenzene, and a volatile organic, chloroform. (2) Thermal decomposition profiles of individual organic compounds introduced as the feed material to the system provided DE (Destruction Efficiency) values for each compound. (3) Products of Incomplete Combustion (PICs) were generated, sometimes in major quantity, that accounted for a large portion of the elemental composition of the feed material. (4) Test series concentrating on the thermal treatment of chloroform showed major differences in PIC generation as a result of different atmospheres (rich oxygen and reduced oxygen). It appeared that several hundred degrees (C) higher temperature would be needed to attain the same degree of destruction of the more refractory PICs in the reduced oxygen atmosphere as was shown in the rich oxygen case.

21086 **(PB—87-131629/XAB) Primary aluminum: statistical analysis of potline fluoride emissions and alternate sampling frequency. Final report.** (Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards). Oct 1986. 166p. (EPA—450/3-86/012). NTIS, PC A08/MF A01.

Statistical analyses were performed on 4 years of fluoride emissions data from a primary aluminum reduction plant. These analyses were used to develop formulae and procedures for use by regulatory agencies in determining alternate sampling frequencies for secondary (roof monitor) emissions testing on a case-by-case basis. Monitoring procedures for ensuring compliance even with a reduced test frequency are also addressed.

21087 **(PB—87-131637/XAB) Review of new source performance standards for primary aluminum reduction plants. Final report.** (Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards). Sep 1986. 121p. (EPA—450/3-86/010). NTIS, PC A06/MF A01.

As required by Section 111 (b) of the Clean Air Act, as amended, a four-year review of the new source performance standards for primary aluminum reduction plants (40 CFR Subpart S) was conducted. The report presents a summary of the current standards, the status of current applicable control technology, and the ability of plants to meet the standards. No revision to the standards are recommended, but EPA should make available a procedure upon which a decision to reduce the frequency of secondary monitoring can be made.

21088 **(PB—87-132817/XAB) Pilot demonstration of the air-curtain system for fugitive-particle control. Final report, June 1982-August 1986.** Williams, R.L.; Duncan, M. (Air Pollution Technology, Inc., San Diego, CA (USA)). Nov 1986. 135p. NTIS, PC A07/MF A01.

The report gives results of the demonstration of the technical and economic feasibility of using an air-curtain-transport system to control buoyant fugitive-particle emissions. (Fugitive emissions are the major source of uncontrolled emissions for many industrial plants. There are now no high-performance, inexpensive control techniques available for many fugitive sources. A simple and inexpensive method is to divert the emissions with an air curtain into a control device located near the source.) A horizontal air curtain was used to capture and convey the buoyant fugitive-particle emissions to a particle-collection filter unit. High-efficiency Particulate Air (HEPA) filters in the filter unit collected the particles. The air curtain capture efficiency, the measure of the air curtain's ability to capture and convey the fugitive emission plume, was between 63 and 105%, depending on air curtain slot exit velocity, and subject to + or - 18% error limit. The overall capture and containment efficiency of the pilot plant, when operating in the appropriate slot velocity range, can be expected to be between 90 and 99% when considered as a package.

21089 **(PB—87-132841/XAB) Investigation of source-emission PM-10 particulate matter field studies of candidate methods. Final report.** Farthing, W.E.; Williamson, A.D.; Dawes, S.S.; Martin, R.S.; Ragland, J.W. (Southern Research Inst., Birmingham, AL (USA)). Dec 1986. 145p. NTIS, PC A07/MF A01.

The report outlines the results of four field tests of two candidate methods for source PM10 measurement. The first method involves a new sampling-train design which incorporates emission gas recycle (EGR) to avoid the anisokinetic sampling bias inherent in size-specific emissions measurement. The second technique, the simulated Method 5 (SIM-5) approach, uses existing sampling hardware with an altered traversing protocol to minimize this bias. The results of the test series suggest that both techniques are sufficiently advanced that they should be documented in more detail for potential use as sampling methods. Further, more extensive testing should be performed in order to define precision, reproducibility, and comparability of each technique as well as identify potential sources of interference or bias.

21090 **(PB—87-132858/XAB) Evaluation of Photovac 10S50 portable photoionization gas chromatograph for analysis of toxic organic pollutants in ambient air.** Berkley, R.E. (Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring Systems Lab.). Dec 1986. 51p. (EPA—600/4-86/041). NTIS, PC A04/MF A01.

The objective of the study was to evaluate the Photovac 10S50 portable photoionization gas chromatograph as a monitor for fourteen selected toxic organic vapors in ambient air. These included benzene, toluene, bromo- and chloro-benzene, o-xylene, and nine halo-methanes, ethanes, and ethylenes. Such analyses have usually been done by gas chromatography using a mass spectrometer as detector (GC/MS). The procedure is inefficient in collection and delivery of analytes to the GC/MS system and limits GC/MS analysis of organic vapors in air to being a semiquantitative method which

may produce misleading results. A portable chromatograph with a detector sensitive enough to detect pollutants without preconcentration could avoid these shortcomings and supplement or complement data obtained by preconcentration/GC/MS.

21091 **(PB—87-133088/XAB) Project MISTT (Midwest Interstate Sulfur Transformation and Transport): measurements and data base. Final report.** Gillani, N.V. (Washington Univ., St. Louis, MO (USA). Dept. of Mechanical Engineering). Dec 1986. 146p. NTIS, PC A07/MF A01.

Project MISTT (Midwest Interstate Sulfur Transformation and Transport) was an EPA-sponsored research program of field measurements and data analyses carried out in the mid-seventies in the St. Louis region. The objective was to investigate quantitatively the dynamics and kinetics of sulfur compounds in the plumes of large power plants and of the St. Louis urban complex during their mesoscale transport. Major field programs were carried out in the summers of 1975 and 1976, involving the participation of about a dozen organizations from around the country. The main approach was to make detailed three-dimensional measurements, both chemical and meteorological, primarily from instrumented airborne platforms, and including support from ground platforms. The report consists of three parts: Part I describes the platforms and the measurements; Part II gives a complete description and documentation of the General Distribution Data Base archived on magnetic tapes; and Part III is an unpublished Appendix providing a summary of each daily mission of the primary sampling aircraft for each of the two summer measurement periods.

21092 **(PB—87-133476/XAB) EPA (Environmental Protection Agency) complex-terrain model development: description of a computer data base from the Full-Scale Plume Study, Tracy Power Plant, Nevada. Final report.** Truppi, L.E. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Dec 1986. 120p. (EPA—600/3-86/068). NTIS, PC A06/MF A01.

As part of the EPA's Complex Terrain Model Development Program, the Full-Scale Study was conducted at the Tracy Power Plant near Reno, Nevada. Sodium oxide tracer gas and oil-fog particles were injected into the base of a 91.4 smokestack, and $CF_3Br$ tracer was released from one of three levels on a 150-m tower upwind from the targeted terrain. During 14 experiments at night or early morning from August 6 to 27, 1984, a tracer concentration data base of over 11,000 hourly samples was accumulated for both tracers at 110 sites. Meteorology data recorded on a 150-m tower included wind, from triaxial propeller anemometers at six levels, sonic anemometers at three levels and temperature from sensors at six levels. All data, tracer and meteorological, were stored on magnetic tape to provide an accessible computer data base. Tape files were fully documented to facilitate utilization of the data base for modeling efforts.

21093 **(PB—87-133708/XAB) Health-hazard evaluation report HETA 84-311-1575, grain elevators, Superior, Wisconsin, and Duluth, Minnesota.** Ahrenholz, S.H. (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA)). Apr 1985. 41p. (HETA—84-311-1575). NTIS, PC A03/MF A01.

Personal air samples were analyzed for carbon disulfide, ethylene dibromide, carbon tetrachloride, and grain dust at grain elevators. The survey was requested by a representative of Local 118 of the American Federation of Grain Millers to evaluate exposures to grain fumigants and dust among workers at the two sites. All concentrations of carbon disulfide, carbon tetrachloride, and ethylene dibromide were below the detection limit. Grain-dust concentrations ranged from 0.34 to 38 milligrams per cubic meter ($mg/m^3$). The American Conference of Governmental Industrial Hygienists threshold limit value for airborne grain dust is 4 $mg/m^3$. Short-term sampling for the fumigants was performed; however, the results were inconclusive. The author concludes that a health hazard due to overexposure to grain dust exists at the grain elevators. Recommendations were made.

21094 **(UCRL—95580) The reality of the greenhouse effect.** MacCracken, M.C. (Lawrence Livermore National Lab., CA (USA)). Oct 1986. Contract W-7405-ENG-48. 22p. (CONF-870414—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87002383.

From 12. world petroleum congress; Houston, TX, USA (26 Apr 1987).

The Earth's surface absorbs solar radiation, to which the atmosphere is mostly transparent, and re-emits infrared radiation that is absorbed primarily by carbon dioxide and water vapor. Without the consequent warming, or "greenhouse" effect, the Earth's mean surface temperature of 15°C would be well below freezing. Changes in the concentration of $CO_2$ and other greenhouse gases can perturb the present climate. Theoretical models constructed to generate quantitative estimates of these changes suggest that a doubling of the $CO_2$ concentration could raise global-average temperatures by 1.5 to 4.5°C. Global temperatures appear to have risen about 0.5°C over the past hundred years, in part probably due to the 25% rise in $CO_2$ concentration. There are important questions, however, regarding the rate and history of the warming and the spatial pattern of the changes. The projected climatic changes could induce significant societal impacts, especially if society is viewed as unresponsive. Sea level rise, reduced water resources, and stressed agricultural systems may be the most important consequences, but uncertainties in the estimated climatic effects and the long lead time make assessment difficult. Developing and evaluating options for slowing the rate and magnitude of and adapting to the projected changes require accelerated research.

21095 **Aerosol sampling efficiency of 37 mm filter cassettes.** Buchan, R.M.; Soderholm, S.C.; Tillery, M.I. (Colorado State Univ., Fort Collins). *American Industrial Hygiene Association Journal;* **47**: No. 12, 825-831(Dec 1986).

This research compared the sampling efficiencies of open- and closed-face 37 mm filter cassettes and an experimental cassette with a tapered inlet. The experiment involved challenging the cassettes with various aerosol sizes up to 24 μm Mass Median Aerodynamic Diameter (MMAD) in a wind tunnel operated at 100 cm/sec. Sampling efficiencies were determined by comparing cassette mass concentration measurements to paired isokinetic samples. It was found that sampling efficiencies dropped with increasing particle size and that the cassette with the tapered entry offered no improvement to sampling efficiency. Sampling efficiency appeared to be improved by placing cassettes on a manikin to simulate personal sampling.

21096 **Impact of indoor environmental parameters on formaldehyde concentrations in unoccupied research houses.** Matthews, T.G.; Fung, K.W.; Tromberg, B.J.; Hawthorne, A.R. (Oak Ridge National Lab., TN). *Journal of the Air Pollution Control Association;* **36**: No. 11, 1244-1249(Nov 1986).

An environmental parameters study has examined the impact of indoor temperature (T) and relative humidity (RH) levels on formaldehyde ($CH_2O$) concentrations inside two unoccupied research houses where the primary $CH_2O$ emitter is particleboard underlayment. The data were fit to a simple three-term, steady state model describing the T and RH dependence of $CH_2O$ concentration in a single compartment with a single $CH_2O$ emitter. The model incorporates an Arrhenius T dependence and a nonlinear RH dependence of the $CH_2O$ vapor concentration within the solid $CH_2O$ emitter. The RH dependence is based on Freundlich's theory of the adsorption of water vapor on solid surfaces. The model is used to estimate potential seasonal variation in $CH_2O$ concentrations under specified experimental conditions inside the research houses. The modeled results indicate six- to ninefold variation between 18°C, 20% RH and 32°C, 80% RH, simulating potential winter/summer conditions with minimal indoor climate control. In comparison, indoor conditions ranging from 20°C, 30% RH to 26°C, 60% RH yielded approximate two- to fourfold fluctuations in $CH_2O$ concentration. The research house data were also used to evaluate the limitations and applicability of more complex five-term models developed from small-scale chamber studies of the environmental dependence of $CH_2O$ emissions from particleboard underlayment.

21097 **Use of an equation solver package for quickly estimating source terms.** Pepper, D.W.; Weber, A.H. (E.I. du Pont de Nemours and Co., Aiken, SC). *Journal of the Air Pollution Control Association;* **36**: No. 11, 1256-1257(Nov 1986). Contract AC09-76SR00001.

The rapid calculation of downwind concentration following an accidental atmospheric release is extremely important. At many processing sites, when an accidental release occurs, initial procedures include the execution of fast, simple computer models to estimate ground level concentrations. Within the last several years, some software companies have advertised software packages for microcomputers known as equation solvers. The objectives of these equation solver programs are to eliminate the necessity of converting mathematical expressions into computational language and to eliminate the need to organize the algorithms into an operational sequence of statements. The user needs only to input the mathematical expressions directly in algebraic form. The program then solves the problem set without requiring reformulation of its rules (equations) as input values are changed for the equation variables.

21098 **Sorbent attrition in the CuO process.** Schultz, H.; Booher, H.B. (U.S. DOE/PETC, Box 10940, Pittsburgh, PA). *American Chemical Society, Division of Petroleum Chemistry, General Papers, Preprints;* **31**: No. 3, 751(Sep 1986). (CONF-860911—).

From 192. American Chemical Society national meeting; Anaheim, CA, USA (7 Sep 1986).

It is estimated that two thirds of the operating costs of the copper oxide flue gas clean-up system are for sorbent replacement. Any improvement in the life expectancy of the sorbent pellets would have a significant effect on the economic viability of the process. The research described in this paper was aimed at determining the causes of sorbent attrition and recommending means for reducing sorbent losses. The copper oxide/alumina sorbents (sorbent A and sorbent B) were studied during life cycle tests where they were subjected to 300 absorption/regeneration cycles. Sampling protocols were devised which allowed the collection of sets unbiased samples of the used sorbent, the regenerated sorbent, and fly ash during the tests. The sorbent pellets that were collected were examined by means of scanning electron microscopy (SEM), X-ray diffraction (XRD), optical microscopy, atomic absorption spectrometry (AAS), and classical chemical analyses. Particular attention was given to fracture boundaries and cross sections of the sorbent pellets. In order to determine the role copper concentration plays in sorbent attrition sorbent pellets were carefully prepared with uniform concentrations of 5%, 7.5%, and 10% copper by weight. These pellets were then subjected to micro-attrition tests so that the attrition rates for pellets with different copper loadings could be determined. Results of the investigations are discussed with emphasis on any evidence indicating chemical causes for pellet attrition.

21099 **The nature of the copper in a Cu/alumina sorbent used in SO/sub 2/ removal from flue gas.** Pollack, S.S.; Chisholm, W.; Obermeyer, R. (U.S. DOE/PETC, Box 10940, Pittsburgh, PA). *American Chemical Society, Division of Petroleum Chemistry, General Papers, Preprints;* **31**: No. 3, 751(Sep 1986). (CONF-860911—).

From 192. American Chemical Society national meeting; Anaheim, CA, USA (7 Sep 1986).

Previous studies have dealt mainly with fresh and reduced sorbents, but in this work, the nature of the compounds in the spent, regenerated, and fresh sorbents used in the removal of SO/sub 2/ from flue gas have been characterized. X-Ray diffraction, Raman, electron spin resonance, thermogravimetric, infrared, magnetic susceptibility, and wet chemical analyses have been carried out. No crystalline CuO is present in the fresh sorbent, but upon reduction with hydrogen, most of the Cu is converted to the metal. In the used sorbent, infrared spectroscopy indicates the presence of sulfate, but again no crystalline sulfate is present. Thermogravimetric analysis shows that the decomposition of the sulfate in the used sorbent occurs 100°C higher than the decomposition of CuSO/sub 4/. The data suggest that in the fresh sorbent the Cu is present as a surface species. In the used sorbent the sulfate is more strongly held than in CuSO/sub 4/ and possibly is bonded to the alumina.

21100 **Industrial hygiene study of a true in situ oil shale retorting facility.** Hargis, K.M.; Tiller, M.L.; Ettinger, H.J.; Brandt, M.T.; Sherman, R.J.; Wheat, L.D. (Los Alamos National Lab., NM). *American Industrial Hygiene Association Journal;* **47**: No. 8, 455-464(Aug 1986).

An industrial hygiene study was conducted at a true in situ oil shale retorting facility located near Vernal, Utah. The study was conducted during operating of the first two in situ oil shale retorts of commercial size at the facility. Air samples were collected for analysis of dust and a number of selected gases and vapors, and limited monitoring was conducted for noise. Limited dust monitoring also was conducted during the drilling of blastholes for a third retorts. Very low concentrations of dusts, and gases and vapors were observed in most areas above the operating oil shale retorts. Higher concentrations of some gases and vapors were observed in small cracks or leaks in the ground surface above the retorts, near a leaking fan that carried retort offgases, and in a confined areas adjacent to tank used for separation and storage of retort oil and water. Observed breathing-zone air concentrations would not exceed established occupational health standards, even if employees were to be exposed for 8 hr. Low levels of polynuclear aromatic hydrocarbons were measured, but the significance of long-term exposure to these compounds is unknown. The limited air sampling conducted during the drilling of blastholes indicated high dust concentrations in the immediate vicinity of the drilling operation; however, personal sampling of employees indicated their exposures were not excessive. Noise levels generally exceeded 8-hr exposure limits in the immediate vicinity of blowers, but workers were not observed to spend much time in these areas.

21101 **Controlling nitrogen oxide and sulfur dioxide emissions with modified calcium hydroxide.** Harkness, J.B.L.; Doctor, R.D.; Wilson, W.I. (Argonne National Lab., Argonne, IL). pp 254-269 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—). Contract W-31-109-ENG-38.

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

Of the additives studied to date, sodium hydroxide and two other additives (P001, P003) have been the greatest enhancement of NO removal over the baseline values for the unmodified calcium hydroxide. However, the authors observed that some of the NO removal was achieved by oxidizing NO to NO/sub 2/. Therefore, the overall NO/sub x/ removal was less than the measured NO removal (but still significant). They concluded that these modified sorbents maintained a significant NO/sub x/ removal activity while in a typical baghouse environment. At the other extreme, Al/CIT and POO2 both depressed the NO/sub x/ removal from the baseline values. Sodium hydroxide and the POO3 additive both showed significant improvement in SO/sub 2/ removal over unmodified calcium hydroxide while sodium sulfite depressed SO/sub 2/ removal. Humidity enhanced NO removal for two additives and depressed for a third. At the same time, SO/sub 2/ removal in general was benefited to an even greater extent. Regretably, additive POO3 had its positive benefits towards NO and SO/sub 2/ removal offset by its humidity interaction. Higher temperatures showed improved NO removal for all additives but in general increasing temperature decreased SO/sub 2/ removal.

21102 **Mesoscale storm and dry period parameters from hourly precipitation data.** Thorp, J.M. (Pacific Northwest Lab., Richland, WA). *Atmospheric Environment;* **20**: No. 9, 1683-1689(1986).

Hourly precipitation data from 89 first-order National Weather Service stations in the northeastern United States are used to define seasonal storm (wet-period) and dry-period statistics. Mean values of regional storm and dry-period duration and of precipitation rates for storms and precipitation events for each season are calculated. Frequency distributions of regional storm and dry period duration allow comparison of seasonal variations and characteristics. Such statistics serve as input parameters for studies and models developed to provide a better understanding of the deposition of acidic pollutants by precipitation.

21103 **Organic acids in springtime Wisconsin precipitation samples.** Chapman, E.G.; Sklarew, D.S.; Flickinger, J.S. (Battelle, Pacific Northwest Labs., Richland, WA). *Atmospheric Environment;* **20**: No. 9, 1717-1725(1986).

A short-term study on organic acids in precipitation was conducted from 15 March to 1 June 1984 at two sites on the Wisconsin Acid Deposition Network. Aliquots of collected samples were fixed with tetrachloromercurate (TCM) and analyzed for low molecular weight organic anions via ion-exclusion chromatography (ICE). Unfixed aliquots were subjected to standard network inorganic analyses. Of the 31 samples collected, 30 contained detectable concentrations of formate and acetate ions, with concentrations ranging from <0.43 to 56 μmol $l^{-1}$ for the former and <0.83 to 33 μmol $l^{-1}$ for the latter. Propionate, oxalate and malonate ions were also detected in a number of samples. Statistical analysis of the combined organic and inorganic data set indicated that no significant differences existed between the concentrations of organic ions at the two sites; however, samples containing visible sediments had significantly greater concentrations than samples without sediments. Maximum contributions of the organic acids to precipitation-free acidity, calculated by assuming that the only sources of the measured formate and acetate were their respective acid forms, averaged 18.6% for samples with a pH ≦5.0. Formate and acetate concentrations were highly correlated. Correlations between organic and inorganic ions were weak; $NH_4^+$ and $Ca^{2+}$ generally exhibited the highest, though still weak, correlations. The study emphasizes the need for further, longer-term investigations to determine the role of low molecular weight organic compounds in precipitation chemistry.

## 5003 Radioactive Materials Monitoring And Transport

*REFER ALSO TO CITATION(S) 21060, 21109, 21111*

21104 **(CEA-CONF—8586) Calculation program of consequences developed for the Crisis Technical Center of the Protection and Nuclear Safety Institut.** Crabol, B.; Manesse, D.; Bouscatie, F. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). Sep 1985. 15p. (In French). (CONF-8509130—5; CEA-DAS—220). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751033.

From Workshop on real-time computing of the environmental consequences of an accidental release to atmosphere from a nuclear installation; Luxembourg, Luxembourg (17 Sep 1985).

IBM 3033; HP 1000.

In case of accident in a nuclear facility, the CEA-Protection and Nuclear Safety Institut (IPSN) specialists, regrouped at the CTC (Technical Center of Crisis) have to do the technical analysis of the situation, to forecast the evolution and, finally to estimate the radioactive releases and the potential consequences for the environment, taking into account the meteorological forecasts which are available. The code SIROCCO, designed for the CTC of the IPSN, uses a gaussian model. It takes into account the emission flow rate, the meteorological changes; it calculates, according to the radioisotope family, the instantaneous and integrated concentrations in the atmosphere and on the ground, and the doses corresponding to the main exposure pathways for short-term effects. This code should be used in case of risk of releases to calculate the potential doses and, to allow the authorities to decide eventual measures for the population protection.

21105 **(DOE/ER/60432—2) Studies of thoron and thoron progeny: Implications for transport of airborne radioactivity from soil to indoor air.** Schery, S.D. (New Mexico Inst. of Mining and Technology, Socorro (USA)). 1986. Contract FG04-86ER60432. 7p. Air Pollution Control Assoc., P.O. Box 2861, Pittsburgh, PA 15230. File Number TI87004492.

In this paper I will summarize some of the major points of our understanding of thoron and its progeny in the outdoor and indoor environments. Then I will focus on some recent work at the New Mexico Institute of Mining and Technology (NMIMT) that suggests that soil may be a major source of indoor thoron for few (one or two)-story housing in the United States. I will try to indicate how such studies can provide useful information for broader questions involving radon and indoor radioactivity.

21106 (IA—1421, pp 180-181) **Reclear. An evacuation simulation model which calculates radiation doses to the evacuated population.** Gants, E.; Tadmor, J. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.

In Research laboratories annual report 1985.

21107 **(KFK—4146) ISOLA IV - a FORTRAN 77 code for the calculation of the long-term dose distribution in the environment of nuclear installations.** Huebschmann, W.; Honcu, S. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Meteorologie und Klimaforschung). Sep 1986. 35p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751275.

The ISOLA computer code is used to calculate the annual radiation doses in the environment of the Karlsruhe Nuclear Research Center, due to the release of α- und β-active substances into the atmosphere. In the version ISOLA IV, the double Gaussian distribution model is strictly applied. As a consequence, the contribution of radioactivity from neighbour sectors is correctly taken into account. This makes possible the input of a 10/sup 0/ statistics as well as a 30/sup 0/ statistics. The code calculates optionally the dose rates due to the following exposure pathways: inhalation, β-submersion, ingestion and irradiation from the ground, the latter two due to dry and wet deposition. Wet deposition can be calculated either according to 'Allgemeine Berechnungsgrundlagen...' /1/ or with individually choosen washout coefficients. An unlimited number of emitters may be taken into account simultaneously. The emission rates are considered to be constant during a given time interval. Optionally, either the isodoses chart of a specified area (for instance a square area of 20 by 20 km) or a list of doses calculated at specified field points (for instance the residential areas) in the environment may be ordered by the user. The input and output are explained for a specific case.

21108 **(RFP—3914) Dust transport: Wind blown and mechanical resuspension, July 1983 to December 1984.** Langer, G. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 20 Sep 1986. Contract AC04-76DP03533. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005794.

This study defines the processes that resuspend plutonium (Pu) particles from Pu-contaminated soil at Rocky Flats. Such knowledge can predict the transport of Pu particles from the site and the population dose. A vertical dust flux tower profiled the plume of Pu particles from the site. The data show a 70% reduction between 1 and 10 m in the concentration of coarse and inhalable Pu particles. The respirable particle concentration remained steady at both heights, slightly above background levels. High winds visually resuspend large amounts of dust for short periods, but we suspected that present sampling devices do not function properly above 50 km/h. During a windstorm reaching 80 km/h, the size-selective sampler used seriously underestimated the dust(Pu) concentration. Wind tunnel studies measured resuspension versus wind speed from our prairie grass covered, arid soil. We failed to find a good correlation between resuspension and wind speed. This led to a search for alternative mechanisms of resuspension besides wind erosion. Resuspension of dust(Pu) from grass proved to be important, as well as resuspension from rain splash.

## 5005 Site Resource And Use Studies

*REFER ALSO TO CITATION(S) 21054, 21108*

21109 **(NUREG/CR—4820) Comparison of the 1982 SEADEX dispersion data with results from a number of different models.** Lewellen, W.S.; Sykes, R.I.; Cerasoli, C.P.; Kornegay, F.C. (Aeronautical Research Associates of Princeton, Inc., NJ (USA); Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Safety). Feb 1987. 161p. (ARAP—575). NTIS, PC A08/MF A01 - GPO. File Number TI87900525.

The results from simulations by 12 dispersion models are compared with observations from an extensive field experiment in a

shoreline environment during the early summer 1982. Ten of these models are the same as used in the earlier comparisons with the 1981 field tests at Idaho National Engineering Laboratory. All the models performed better on this SEADEX experiment. Little difference between the models is evident with hourly surface data, with the models able to predict the maximum value in the neighborhood of a sampler site within a factor of 2 approximately 25% of the time. This is raised to approximately 40% when the comparison is based on 12 hour integrated dose. For the longer time samples the more sophisticated models do show a distinct advantage when measured by correlation coefficient and root mean square error. If the data file is assumed incomplete, with higher data samples possible between the actual data samples, then the best results for the hourly samples show over 80% calculated within a factor of 2 when a $15^0$ uncertainty in the plume position is permitted. This is raised to 90% for the 12 hour dose on the same comparison basis. We believe the data for this experiment are of sufficiently high quality that the more stringent interpretation of these tests given first are justified.

### 5006 Regulations

*REFER ALSO TO CITATION(S) 20459, 21086, 21087*

21110 **(DOE/BP/18690—4) Overview of indoor air quality legislation and government programs.** Young, J.K.; Wilfert, G.L. (Pacific Northwest Lab., Richland, WA (USA)). Oct 1986. Contract AC06-76RL01830. 44p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005935.

This report overviews the regulatory actions taken by national and state institutions to promote acceptable indoor air quality (IAQ). The findings of the report are divided into (1) regulatory measures and (2) remedial or preventative programs. Regulatory measures take the form of mandatory standards or voluntary guidelines. Remedial or preventative programs promote acceptable IAQ through response to complaints, research, and public education. Important actions of other countries in these areas are also discussed. National, stte, and foreign standards that regulate indoor air quality are described. Along with regulations in other countries and specific nonregulatory IAQ programs pertaining to residences which exist at the national and state level.

21111 **(LBL—21641) Distribution of indoor radon concentrations and elements of a strategy for control.** Nero, A.V. Jr. (Lawrence Berkeley Lab., CA (USA)). May 1986. Contract AC03-76SF00098. 19p. (CONF-8603172—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87003529.

From Governor's conference on indoor radon; Albany, NY, USA (4 Mar 1986).

Indoor radon concentrations vary widely in the US housing stock, with normal concentrations estimated to cause a significant risk of lung cancer by comparison with environmental exposures normally considered, and high concentrations causing risks that exceed even those from cigarette smoking. The probability distribution, i.e., the number of houses at various concentrations, can be estimated from an analysis of the US indoor radon data accumulated to date. Such an analysis suggests that in about a million houses, occupants are receiving exposures greater than those experienced by uranium miners. The form of the frequency distribution, including not only the average concentration, but also the number of houses with high levels, has substantial influence on strategies for control of indoor radon. Such strategies require three major elements: formulation of control objectives in terms of guidelines for remedial action and for new houses; selection of means for identifying homes with high concentrations; and a framework for deciding what types of control measures are appropriate to particular circumstances and how rapidly they should be employed.

## 51 ENVIRONMENTAL SCIENCES, TERRESTRIAL

### 5101 Basic Studies

*REFER ALSO TO CITATION(S) 20059*

21112 **(CONF-870380—1) Estimating forest productivity in southern Illinois using Landsat thematic mapper datn and geographic information system analysis techniques.** Cook, E.A.; Iverson, L.R.; Graham, R.L. (Illinois Inst. of Natural Resources, Champaign (USA). Illinois Natural History Survey; Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005711.

From American Society of Photogrammetric Engineering and Remote Sensing; Baltimore, MD, USA (22 Mar 1987).

Ecological researchers have recently begun to explore the potential of remote sensing in addressing questions about the structural and functional properties of ecosystems. The objective of our research is to analyze the relationship of Landsat Thematic Mapper (TM) data and field-collected measurements of forest productivity in southern Illinois. In addition to TM data, such site characteristics as slope angle and position, soil productivity indexes, and sun radiance factors were incorporated in the analysis. Techniques for using image and geographic information system data in relation to productivity measurements taken in the field are discussed. Correlation and multiple regression results revealed the importance of TM band ratios 7:4 and 2:1 and of the woodland productivity indexes of soils in predicting forest productivity. Directions for further research in this area are suggested.

21113 **(DOE/ER/60277—T1) Global change in the geosphere-biosphere: Initial priorities for an IGBP [International Geosphere-Biosphere Program: Final report].** (United States Committee for an International Geosphere-Biosphere Program, Washington, DC). 1986. Contract FG05-84ER60277. 103p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87005034.

This report outlines the elements of a program that is focused sharply on fundamental problems that have urgent practical implications. These elements define a program that would attempt to understand the workings of the Earth and the living organisms on it as a coupled system - a challenge in science that holds the promise of elucidating many of the global concerns of the present day. It would require the participation of many nations and draw upon the efforts of many fields of science. It would be made up of an array of planned, cooperative programs of observation, modeling, and process studies with organized opportunities for joint discussion and interpretation. It would lean on spaceborne observations for global perspective, but it is not a "space program," for the preponderance of needed science would deal with processes of change, and vast majority of necessary measurements would need be made on the ground and on the oceans, from within the habitat of life. As an international program it would stand as a separate, focused endeavor that interacts with related, disciplinary programs to increase their effectiveness but without attempting to subsume them or to dictate their goals.

21114 **(DOE/OR/00033—T282) Forest bird demography in a landscape mosaic.** Urban, D.L. (Tennessee Univ., Knoxville (USA); Oak Ridge Associated Universities, Inc., TN (USA)). Dec 1986. Contract AC05-76OR00033. 163p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE87005987.

A tandem approach of field studies and simulation modeling was used to examine avian demography in a landscape mosaic of habitat patches. A particular goal was to attempt to account for the regional decline in abundance of a subset of bird species sensitive to forest fragmentation. Species abundance patterns in forest patches were framed as the consequence of individual birds' demographics, constrained by their landscape context; this context was partitioned to emphasize habitat availability (or area), accessibility (or isolation), and localized factors affecting reproductive success (nest pre-

dation and brood parasitism). Each of these constraints was examined in turn, to assess their relative contribution to species abundance patterns observed in landscape mosaics. A forest simulation model was used to develop a theoretical basis for the importance of microhabitat pattern in forest bird communities. Hypotheses about microhabitat variety and bird species distribution in landscapes were not supported by data from woodlots in Cadiz Township, southern Wisconsin. The hierarchical conceptual model developed in this study represents a synthetic general model, a framework that can be simplified under specified scenarios to provide predictions about bird species abundance patterns in landscape mosaics.

21115 **(INIS-BR—569) Profile characterization of soil developed on pelitic rocks from the Bambui Group through chemical analysis, X-ray diffraction and Moessbaur spectroscopy.** (Vicosa Univ. (Brazil)). Jul 1986. 100p. (In Portuguese). NTIS (US Sales Only), PC A05/MF A01. File Number DE87700917.

Five sample from a red-yellow latosol developed on pelitic rocks from the Bambui Group, located close to Paraopeba, state of Minas Gerais, Brazil, were collected and studied. The sample with color patterns varying from yellowish (sample SL11; 0.3m depth), in superficial horizons, to reddish (SL12; 1.0m) in intermediate profile positions, and various shades (SL14A and SL14V; 3.0m), in deeper horizons, were studied through Moessbauer spectroscopy in order to characterize, in detail, the ferruginous species present. The total iron content within the soil is practically constant in relation to the depth. Yet, the hematite/goethite content ratio varies within the expected sequence according to the color. A linear relationship was observed between the reddish intensity and the hematite content of the argillaceous fraction. The hematite contents are proportionally less in the SL14A sample, apparently due to deficient drainage in the past, and in the SL11 sample, due to organic matter effects. This latter sample is also characterized by at least two goethite populations: one with 20% mol replacing aluminum and another with certainly more than 30% mol. In to explan this difference, three hypothesis were elaborated. The most suitable one suggests that the goethite is destroyed and formed again through the soil column, in response to pedo environmental changes closer to the surface. (D.J.M.).

21116 **(LA—10865-MS) Root lengths of plants on Los Alamos National Laboratory lands.** Tierney, G.D.; Foxx, T.S. (Los Alamos National Lab., NM (USA)). Jan 1987. Contract W-7405-ENG-36. 62p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006316.

Maximum root lengths of 22 plant species occurring on Los Alamos National Laboratory lands were measured. An average of two longest roots from each species were dug up and their lengths, typical shapes, and qualitative morphologics were noted along with the overstory dimensions of the plant individual with which the roots were associated. Maximum root lengths were compared with overstory (height times width) dimensions. Among the life forms studied, the shrubs tend to show the longest roots in relation to overstory size. Forbs show the shortest roots in relation to overstory size. Measurements of tree roots suggest only that immature trees on the Pajarito Plateau may have root-length to overstory-size ratios near one. 30 refs., 14 figs., 2 tabs.

## 5102 Chemicals Monitoring And Transport

*REFER ALSO TO CITATION(S) 21065, 21133, 21230*

21117 **(AD-A—175343/3/XAB) Installation-restoration program Phase II - confirmation/quantification Stage 1 for Air Force Plant PJKS, Waterton, Colorado. Volume 1. Final report, October 1985-October 1986.** (Engineering-Science, Inc., Denver, CO (USA)). 6 Oct 1986. 408p. NTIS, PC A18/MF A01.

See also Volume 2, AD-A175 344.

A field investigation was conducted to confirm or deny the presence of hazardous wastes at eight sites at Air Force Plant PJKS near Western, Colorado. Activities at the plant that could have generated hazardous wastes include the development and testing of rocket engines. The field program included sampling of surface waters, soils, and sediments, and the installation and sampling of eight ground-water-monitoring wells. Hazardous substances found at the eight sites included TCE and other halocarbons, NDMA (a decomposition product of hydrazine), phenols, trace amounts of heavy metals, including arsenic, hexavalent chromium, and selenium. Elevated levels of radiation were detected in ground waters downgradient from a landfill known to contain a small amount (25 kilograms) of low-level radioactive magnesium-thorium alloy. Since natural uranium mineralization occurs within the area, the background level of radiation needs to be established before the significance of the measured radiation can be determined. Contamination of soils and sediments was determined to be of low significance because of the low levels of contamination and a lack of pathways for offsite migration. Contamination of surface and ground waters at sites 1, 2, 4, 5, and 11 was judged to be moderately significant because the contaminants occurred at concentrations exceeding standards or guidelines to protect human health, and the potential for contaminant migration exists. Plans for future studies to determine the sources an extent of surface- and ground-water contamination were developed.

21118 **(AD-A—175344/1/XAB) Installation-restoration program Phase II - confirmation/quantification Stage 1 for Air Force Plant PJKS, Waterton, Colorado. Volume 2. Final report, October 1985-October 1986.** (Engineering-Science, Inc., Denver, CO (USA)). 6 Oct 1986. 462p. NTIS, PC A20/MF A01.

See also Volume 1, AD-A175 343.

A field investigation was conducted to confirm or deny the presence of hazardous wastes at eight sites at Air Force Plant PJKS near Waterton, Colorado. Activities at the plant that could have generated hazardous wastes include the development and testing of rocket engines. The field program included sampling of surface waters, soils, and sediments, and the installation and sampling of eight ground-water-monitoring wells. Hazardous substances found at the eight sites included TCE and other halocarbons, NDMA (a decomposition product of hydrazine), phenols, and trace amounts of heavy metals, including arsenic, hexavalent chromium, and selenium. Elevated levels of radiation were detected in ground waters downgradient from a landfill known to contain a small amount (25 kilograms) of low-level radioactive magnesium-thorium alloy. Since natural uranium mineralization occurs within the area, the background level of radiation needs to be established before the significance of the measured radiation can be determined. Contamination of soils and sediments was determined to be of low significance because of the low levels of contamination and a lack of pathways for offsite migration. Contamination of surface and ground waters at sites 1, 2, 4, 5, and 11 was judged to be moderately significant because of the low levels of contaminations occurred at concentrations exceeding standards or guidelines to protect human health, and the potential for contaminant migration exists. Plans for future studies to determine the sources and extent of surface and ground water contamination were developed. (Author)

21119 **(DOE/ER/60179—3) Chemical processes in forest soils: Final report.** Zelazny, L.W.; Evans, A. Jr.; Riha, S.J.; James, B.R.; Bartlett, R.J.; Magdoff, F.R. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Dec 1986. Contract AS05-83ER60179. 28p. NTIS, PC A03. File Number DE87005515.

This final report provides an overview of three related research projects concerned with acid rain effects on soils. The first addressed problems associated with the transport of soluble constituents through soil minerals. Of particular concern was aluminum, whose solid-solution partitioning is complicated by numerous physical and chemical processes. The second project determined the extent to which vegetation should be considered in characterizing soil sensitivity to anthropogenic inputs. The last dealt with aluminium mobility and reactivity reflecting effects of organic matter, freezing and thawing, redox, ionic strength, and acidity of the rain. (ACR)

21120 **(ORNL—6239) Long-term problems of land contaminated by nonradioactive hazardous chemicals: Sources, impacts, and countermeasures: Environmental Sciences Division publication No. 2823.** Baes, C.F. III; Garten, C.T. Jr.; Tolbert, V.R. (Oak Ridge National Lab., TN (USA)). Jan 1987. Contract AC05-84OR21400. 196p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE87006008.

This report examines the environmental behavior and fate of nonradioactive hazardous chemicals, methods for assessing environmental impacts, and alternatives for achieving land decontamination and cleanup. Nonradioactive hazardous chemicals can be reactive, corrosive, or toxic. Reactive chemicals may be explosive, flammable, or capable of undergoing spontaneous change upon exposure to air, water, or a mixture of other chemicals. Toxic chemicals have a high probability of being carcinogenic, mutagenic, teratogenic, or lethal to humans and wildlife. Three types of simple models are currently in use for assessing ecotoxicological hazard of hazardous chemicals: the benchmark approach; the Quantitative Structure Activity Relationship models; and screening models are evaluated. Cleanup of hazardous contaminants on land may involve dispersal, removal and storage, stabilization, or treatment. Both dispersal and removal/storage alleviate acute, local, immediate threats, but additional remedial action may eventually be necessary. Stabilization and treatment are more permanent solutions. Stabilization involves methods to isolate the contaminant or limit its dispersal. Treatment involves biological, chemical, and physical approaches to detoxify or destroy the hazardous chemicals.

21121 **(PB—87-129318/XAB) Observations on the behavior of bowhead whales (Balaena mysticetus) in the presence of operating seismic exploration vessels in the Alaskan Beaufort Sea.** Ljungblad, D.K.; Wuersig, B.; Swartz, S.L.; Keene, J.M. (Naval Ocean Systems Center, San Diego, CA (USA)). Oct 1985. 88p. NTIS, PC A05/MF A01.

The response of bowhead whales to active geophysical vessels was observed during the course of 4 field experiments conducted in the Alaskan Beaufort Sea, September 1984. Conspicuous short-term behavioral changes were observed when active vessels approached to within 10km of bowheads, with the strongest responses occurring when whales were within 5km of active vessels. Behavioral responses included shorter surfacing and dive times, fewer blows per surfacing, and longer blow intervals. Total avoidance responses occured at vessel distances of 1.25km, 7.2km, 3.5km and 3.5km with associated measured sound levels from the seismic airgun arrays of 152dB, 164dB, 178dB and 163dB, respectively.

21122 **(PB—87-129557/XAB) Geotextiles for drainage, gas venting, and erosion control at hazardous waste sites. Final report 1981-1985.** Horz, R.C. (Army Engineer Waterways Experiment Station, Vicksburg, MS (USA). Geotechnical Lab.). Sep 1986. 158p. NTIS, PC A08/MF A01.

The document provides information on the properties of geotextiles (engineering fabrics) and on the potential uses of geotextiles at hazardous waste sites. While primarily intended to assist those involved in the design of remedial measures for uncontrolled hazardous-waste landfills, the design procedures and criteria set forth could prove equally useful to those designing controlled land-disposal facilities. This report is also intended to be a source of technical information to aid regulatory personnel in evaluating designs submitted for approval. Subjects discussed include the types of fabrics and related products currently available, the various functions of these fabrics, test methods for evaluating potential fabric performance, recommended design procedures for using geotextiles and related products in drainage and erosion control systems, and recommended installation procedures for the various applications.

## 5103 Radioactive Materials Monitoring And Transport

*REFER ALSO TO CITATION(S) 20120, 20122, 21105, 21107*

21123 **(IPPJ-DT—116) Measurements of environmental radiations and radioactivities in Toki, (3).** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jul 1985. 21p. (In Japanese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700958.

In this issue two reports are given from the 1983 IPP-Toki collaborational works of surveying environmental radiations and radioactivities over the Toki area. One of them is concerned with the TLD observations of radiation levels by a team of local school teachers, and the other shows the results of sample measurements due to gamma- and alpha- spectrometry by the IPP group. In addition, a map of background radiation levels in Japan is included for the reference use.

21124 **Uptake by sagebrush of uranium progeny injected in situ.** Simon, S.L.; Fraley, L. Jr. (Colorado State Univ., Ft. Collins). *Journal of Environmental Quality;* **15**: No. 4, vp(Oct-Dec 1986). Contract AC02-79EV10305.

Uptake of $^{226}$Ra, $^{210}$Pb, and $^{210}$Po in mature big sagebrush (Artemisia tridentata) was studied in the environs of a U mine in Shirley Basin, WY. Radionuclide solutions were injected into the soil to elevate the soil activity while minimizing root disturbance and preventing soil surface contamination. The objectives of this study were to measure the concentration in leaves resulting from root uptake as a function of time and to determine the equilibrium concentration ratio (CR) for each radionuclide. The vegetation was sampled approximately every 90 d for a 2-yr period. The maximum internal plant concentration of $^{226}$Ra, $^{210}$Pb, and $^{210}$Po was detected at the first sampling (81 d after soil injection for $^{226}$Ra, 28 d for $^{210}$Pb and $^{210}$Po). The concentration in leaves decreased over time following the first sampling to an apparent steady-state value. The steady-state CR values for $^{226}$Ra, $^{210}$Pb, and $^{2100}$Po, as determined in mature sagebrush, were approximately 0.04, 0.009, and 0.08, respectively, and were determined as the geometric mean (GM) of the CR data pooled over the 2nd-yr period. The CR data were fit by nonlinear least squares to a exponential function that decreased with time to a constant value.

## 5105 Site Resource And Use Studies

*REFER ALSO TO CITATION(S) 21108*

21125 **(EGG—10282-2133) Wildlife management plan, Naval Petroleum Reserve No. 1, Kern County, California.** O'Farrell, T.P.; Scrivner, J.H. (EG and G Energy Measurements, Inc., Goleta, CA (USA). Santa Barbara Operations). Jan 1987. Contract AC08-83NV10282. 66p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87005864.

Under the Naval Petroleum Act of 1976, Congress directed the Secretary of the Navy and subsequently the Secretary of Energy, to produce petroleum products from Naval Petroleum Reserve No. 1 (NPR-1) in Kern County, California, at the maximum efficient rate consistent with sound engineering practices. Because of the presence of two endangered species and the quality, quantity, and contiguous nature of habitat on NPR-1, the area is unique and management of its resources deserves special attention. The purpose of this wildlife management plan is to: (1) draw together specific information on NPR-1 wildlife resources; (2) suggest management goals that could be implemented, which if achieved, would result in diverse, healthy wildlife populations; and (3) reinitiate cooperative agreements between the US Department of Energy (DOE) and other conservation organizations regarding the management of wildlife on NPR-1. NPR-1 supports an abundant and diverse vertebrate fauna. Twenty-five mammalian, 92 avian, eight reptilian, and two amphibian species have been observed on Elk Hills. Of these, three are endangered (San Joaquin kit fox, Vulpes macrotis mutica; giant kangaroo rat, Dipodomys ingens; blunt-nosed leopard lizard, Gambelia silus). Nine vertebrates, six invertebrates, and four plant species known to occur or suspected of occurring on Elk Hills are potential candidates for listing. A major objective of this management plan is to minimize the impact of petroleum development activities on the San Joaquin kit fox, giant kangaroo rat, blunt-nosed leopard lizard, and their essential habitats. This will mainly be achieved by monitoring the status of these species and their habitat and by restoring disturbed habitats. In general, management policies designed to benefit the above three species and other species of concern will also benefit other wildlife inhabiting NPR-1.

21126 **(NP—7751610) Revegetation of the Helmstedt brown-coal mining area. A contribution in landscape planning and economy.** Fittkow, C. (Technische Univ. Berlin (Germany, F.R.). Fachbereich Landschaftsentwicklung). 1985. 80p. (In German). NTIS (US Sales Only), PC A05/MF A01. File Number DE87751610.

The aim of the revegetation scheme of 'Braunschweigische Kohlen-Bergwerke' is to create useful areas for agriculture and forestry. There does not exist for the Helmstedt revegetation area a land use concept designed to develop the landscape in a manner that both the demands of society on landscape will be satisfied, and nature's innate dynamics are taken into account. The setting up of a revegetation plan in accordance with ecological criteria - succession, close-to-nature vegetation units, the diversity characteristic of biotopes - is absolutely indispensable in order to create a balanced landscape system in the Helmstedt area in the long run. A revegetation design which is based mainly on intensive agricultural utilization of the land will not meet the demands of revegetation along landscape-planning and ecological lines. Following an analysis of the individual revegetation measures of 'Braunschweigische Kohlen-Bergwerke', this book presents recommendations for a revegetation of the Helmstedt brown-coal mining area along landscape-planning and ecological lines.

# 52 ENVIRONMENTAL SCIENCES, AQUATIC

## 5201 Basic Studies

*REFER ALSO TO CITATION(S) 20059, 21113, 21289*

21127 **(BNL—38942) Is the Somali Current a biological river in the Northwestern Indian Ocean?.** Smith, S.L. (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 15p. (CONF-8603173—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003233.

From Symposium on marine biology of the Arabian Sea; Karachi, Pakistan (29 Mar 1986).

Calculations of diversity, equitability, average rank, and average percentage of total numbers show that the addition of zooplanktonic taxa such as Calanus carinatus arising in the upwelling areas during the southwest monsoon does significantly increase diversity and equitability of the community. Rank and percentages of total numbers, however, show that the response is not entirely due to the presence of Calanoides carinatus during the southwest monsoon. Another important change in the zooplanktonic community was the decline in the abundance of Oithona spp. in upwelling areas during the southwest monsoon.

21128 **(BNL—38988) Production and remineralization in continental shelf ecosystems: A test of the SEEP hypothesis.** Rowe, G.T. (Brookhaven National Lab., Upton, NY (USA)). Sep 1986. Contract AC02-76CH00016. 39p. (CONF-8609246—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87003470.

From Benguela '86; Cape Town, South Africa (8 Sep 1986).

The hypothesis that continental shelf ecosystems export a major fraction of the carbon produced by the phytoplankton during the spring bloom was tested during the Shelf Edge Exchange Processes (SEEP) experiment off the northeast US coast in 1984. This study, along with a reanalysis of traditional concepts, leads to the conclusion that only a small fraction of continental shelf phytodetritus is exported across a distinct shelf-slope hydrographic frontal system. What is not consumed in the spring is utilized on the shelf during the ensuing stratified season. More open ended ecosystems may export production more readily. The total benthic standing stocks in terms of organic carbon (macrofauna, meiofauna, and bacteria) have been estimated in the SEEP area. Their preponderance on the continental shelf was partial evidence that little organic matter escapes to the upper continental slope. Measurements of the metabolism of the biota allowed calculation of turnover times of organic detritius and the total biota. The turnover time of detritus increased as grain size decreased, suggesting that fine-grained deposits contain mostly refractory, nonreactive compounds, especially on the deep slope. Turnover times of the total biota were about the same in the coarse versus fine-grained shelf deposits, but a far larger fraction of the turnover was attributed to the bacteria in the fine sediments than in the coarse. On average, about 25% of the primary production appeared to be utilized by the aerobic benthos on the continental shelf in the SEEP area. The role of anaerobes at depth in the sediments remains uncertain.

## 5202 Chemicals Monitoring And Transport

*REFER ALSO TO CITATION(S) 19984, 20078, 20079, 20080, 20081, 20082, 20083, 20084, 20085, 20086, 20089, 21117, 21118, 21122, 21245, 21257*

21129 **(DOE/ER/60152—1-Pt.2, pp 805) Hydrogeochemical characteristics of the Caltech radon-thoron monitoring network.** Guiru, L.; Fongliang, J.; Melvin, J.D.; Rice, A.; Shapiro, M.H.; Tombrello, T.A. (State Seismological Bureau, Beijing, China). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

To better understand the meteorological and hydrogeological factors which affect radon monitoring, the authors have investigated the geotectonic setting, hydrogeological conditions, and geochemical environment at several sites of the Caltech radon-thoron monitoring network. Groundwater samples from the boreholes used for radon monitoring were collected before and after rainfall. These samples were analyzed for pH, $CO_2$, $HCO_3^-$, $SO_4^{-2}$, $K^+$, $Na^+$, $CA^{+2}$, $Mg^{+2}$, $H_2SiO_3$, U, Th, Ra, Rn. The D/H, $^{18}O/^{16}O$ ratios for the water samples were determined, and U and Th concentration in the rock samples from the same sites were measured. The groundwater at the sites investigated appears to be basement rock fissure water of meteoric origin of the HCO-Ca-Na (Mg) type. The concentrations of radon and other ions in these water samples were not influenced strongly by the light precipitation of the 1980-81 winter. A good correlation was observed between the radon concentrations in the water of the boreholes and concentrations of U and Ra in the water and surrounding rocks. Thus, the radon concentrations are somewhat dependent on changes in the U and Ra concentrations in the groundwater.

21130 **(PB—87-129300/XAB) Seasonal variability in Prickly Pear Creek water quality and macroinvertebrate communities.** Baldigo, B.P.; Baker, J.R.; Kinney, W.L.; Fillinger, M. (Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV (USA)). Dec 1986. 44p. NTIS, PC A03/MF A01.

Prickly Pear Creek, Montana, was sampled during four seasons in 1982 and 1983 to attempt to relate biological responses to fluctuations in discharge, in-stream toxicity, and metal concentration in the water column. The biota (macroinvertebrate) were definitely impacted directly downstream from a metal source during all seasons, but no definite relationships among discharge, metal concentration, and biological response could be established on a seasonal basis.

21131 **(PB—87-129425/XAB) Report to the Congress on ocean pollution, monitoring, and research, October 1984 through September 1985.** (National Oceanic and Atmospheric Administration, Washington, DC (USA)). May 1986. 80p. NTIS, PC A05/MF A01.

See also PB—85-107076.

Under Section 201 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended, the Congress assigned to the Department of Commerce the responsibility to monitor and research the effects of dumping wastes into the ocean. The report describes the ocean-pollution activities carried out by the National Oceanic and Atmospheric Administration during fiscal year 1985. It describes results from a comprehensive, continuing program of assessment, including research, development, and monitoring, on the short- and long-term effects of human activities on the marine environment.

21132 **(PB—87-129516/XAB) Measurements of oil concentrations in the water column, under breaking waves.** Nilsen, J.; Naess, A.; Volent, Z. (Norsk Hydroteknisk Lab., Trondheim). 10 Jun 1985. 103p. NTIS, PC PC E06/MF E06.

Also published as Selskapet for Industriell og Teknisk Forskning, Trondheim (Norway) rept. no. STF60-A85079.

New fiber-optical transmittance meters were constructed to measure oil concentrations in water continously. The instruments have been calibrated using different particle size distributions of Statfjord crude oil, 70/30 water-in-oil emulsion, and chemically dispersed Statfjord crude oil. The results of the calibration tests showed that it was possible to measure oil concentrations from 500 ppb to 5000 ppm depending on the particle size distribution. Stokes expression for the settling velocity and the continuous concentration measurements, were used to calculate a dominating oil-particle diameter. Slicks of Statfjord crude oil, 70/30 water-in-oil emulsion and chemically dispersed crude oil (Corexit 9527) were exposed both to single and series of breaking waves.

21133 **(PB—87-131736/XAB) Characterization of a landfill-derived contaminant plume in glacial and bedrock aquifers, NE Illinois.** Booth, C.J.; Vagt, P.J. (Illinois Univ., Urbana (USA). Water Resources Center). Jul 1986. 95p. (UIUC-WRC—86-202). NTIS, PC A05/MF A01.

Groundwater contamination by organic and inorganic chemicals is a regional and national problem; landfills are major potential contaminant sources. In the study of the Blackwell landfill, DuPage County, Illinois the contaminant plume is delineated and related to the site history and hydrogeology. Leachate leakage is attributed partly to landfill construction problems. The landfill is located partly on a sand-and-gravel aquifer and partly on thick, poorly permeable till, all overlyirg an important dolomite aquifer. A leachate leakage rate of between 600 and 3000 $ft^3$/day was estimated from infiltration and leachate-level calculations. The study has generated considerable field data which should be valuable in future studies.

21134 **(PNL-SA—14527) Small-diameter casing for standpipe monitoring wells: A comparison of current alternatives.** Schalla, R.; Myers, D.A. (Pacific Northwest Lab., Richland, WA (USA)). Jan 1987. Contract AC06-76RL01830. 17p. (CONF-870145—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87004917.

From Standards development for ground water monitoring meeting; Tampa, FL, USA (20 Jan 1987).

The standpipe monitoring well is the most common and accepted system for monitoring the chemical quality of ground water. The majority of these wells have a diameter of 2 inches or less. The lower cost of the small-diameter wells makes them the preferred choice. However, the technology available to properly develop, sample, and monitor such wells has evolved gradually over the last several years, and with its changes and improvements have been made in the design of the standpipe monitoring well. The variety of threaded couplings used to join sections of casing or screen are quite diverse, and current designs of the flush-threaded type are surprisingly incompatible. The designs differ in the types of threading and seals, the variety of materials, the actual pipe and coupling lengths, the pipe thickness (schedule), and pipe cleaning procedures. A national standard design is needed for flush-threaded casting used to construct monitoring wells.

21135 **Regional accumulation amounts per unit area of persistent pollutants derived from analyses of recent sediments.** Simpson, H.J.; Bopp, R.F.; Deck, B.L.; Larsen, R.J. (Columbia Univ., Palisades, NY). *Memorie della Societa Geologica Italiana;* **27**: vp(1984). Contract AC02-76EV12529.

Detailed contaminant measurements in fine-grained sediment cores which penetrate through recent layers to reach background, uncontaminated sediments can be combined with data on fallout and natural radionuclides on the same samples to derive both contaminant history and estimates of total pollutant accumulation per unit area. To extrapolate data from one or more sediment cores as representative of a region, the known rate of weapons-testing fallout and natural radionuclide delivery from the atmosphere can be used to normalize the record derived from individual cores. Examples of sediment radionuclide and pollutant data from Lake Michigan, Washington continental shelf, southern California coastal waters, Hudson River, and Chesapeake Bay provide quantitative estimates of the total accumulation per unit area of trace metals and chlorinated hydrocarbons to several natural systems over the last three or four decades. The normalization scheme employed is best suited for pollutants derived predominantly from the atmosphere and delivered to water systems which lose relative little sediment to other systems. The regional pollutant accumulation per unit area derived includes the sum of atmospheric and surface contamination. Although interpretation of contaminant concentration data in sediments is complicated, the sediment record provides one of the best integral methods available for making quantitative estimates of long-term pollutant transport processes and delivery rates. 45 references, 9 figures, 14 tables.

## 5203 Radioactive Materials Monitoring And Transport

*REFER ALSO TO CITATION(S) 20077, 20078, 20079, 20080, 20081, 20082, 20083, 20084, 20086, 20089, 20090, 20096, 20097, 20117, 20120, 20130, 20138, 21123, 21129, 21135, 21240, 21242, 21243*

21136 **(DOE/ER/60172—2) The oceanic geochemistry of artificial radionuclides: The "SEEP" project: [Final] progress report for period 1 August 1986-31 July 1987.** Sholkovitz, E.R.; Livingston, H.D. (Woods Hole Oceanographic Institution, MA (USA)). Mar 1986. Contract AC02-83ER60172. 52p. NTIS MF A01; 2; GPO Dep. File Number DE87005705.

The objective of the SEEP project was to quantify the biological and geochemical processes controlling the concentration, distribution, flux, and speciation of natural and artificial radionuclides. The focus is on the shelf/slope region. Research was concentrated on the sediment chemistry of plutonium and on the nature of fallout transuranic transport in, and removal from, waters of the US continental margin. (ACR)

21137 **(Y/DZ—234) Recycle and biodestruction of hazardous nitrate wastes.** Napier, J.M.; Kosinski, F.E. (Oak Ridge Y-12 Plant, TN (USA)). 12 Jan 1987. Contract AC05-84OS21400. 15p. (CONF-870377—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005914.

From International congress on recent advances in the management of hazardous and toxic wastes in the process industries; Vienna, Austria (8 Mar 1987).

The US Department of Energy (DOE) owns the Oak Ridge Y-12 Plant located in Oak Ridge, Tennessee. The plant is operated for DOE by Martin Marietta Energy Systems, Inc. One of the plant's functions involves the purification and recycling of uranium wastes. The uranium recycle operation uses nitric acid in a solvent extraction purification process, and a waste stream containing nitric acid and other impurities is generated. Before 1976 the wastes were discarded into four unlined percolation ponds. In 1976, processes were developed and installed to recycle 50% of the wastes and to biologically decompose the rest of the nitrates. In 1983 process development studies began for in situ treatment of the four percolation ponds, and the ponds were treated and discharged by May 1986. The treatment processes involved neutralization and precipitation to remove metallic impurities, followed by anaerobic denitrification to reduce the 40,000 ug/g nitrate concentration to less than 50 ug/g. The final steps included flocculation and filtration. Approximately 10 million gallons of water in the ponds were treated and discharged.

## 5205 Site Resource And Use Studies

21138 **(NWRC-OFR—86-6) Data bases for use in fish and wildlife mitigation planning in Tampa Bay, Florida: Project summary.** Fehring, W.K. (Greiner Engineering, Inc., Tampa, FL (USA)). Sep 1986. 46p. Fish & Wildlife Service, N.W.R.C., 1010 Gause Blvd., Slidell, LA 70458. File Number TI87900408.

This report summarizes the history, objectives, activities, and results of a 3-year cooperative project by the US Fish and Wildlife

Service (FWS) and the Tampa Port Authority (TPA) to improve the data base available for making decisions regarding port development and wildlife habitat management in Tampa Bay. In addition, the report describes situations in which the study methods, results, and products might be used to improve management and development decisions regarding fish and wildlife resources in the bay. Individual projects which have generated separate products such as maps, booklets, and reports are described.

### 5206 Regulations

*REFER ALSO TO CITATION(S) 19925*

**21139 (PB—87-133484/XAB) Development document for effluent-limitations guidelines and standards for the nonferrous metals forming and metal powders: point source category. Volume 3. Final report.** Thomas, L.M.; Jensen, L.J.; Whittington, W.A. (Environmental Protection Agency, Washington, DC (USA). Industrial Technology Div.). Sep 1986. 961p. (EPA—440/1-86/019). NTIS, PC A99/MF E06.

Table of contents includes the following: Summary and conclusions; Recommendations; Introduction; Industry subcategorization; Water use and waste-water characteristics; Selection of pollutant parameters; Control and treatment technology; Cost of wastewater treatment and control; Best practicable control technology currently available; Best available technology economically achievable; New source performance standards; Pretreatment standards; Best conventional pollutant-control technology.

## 55 BIOMEDICAL SCIENCES, BASIC STUDIES

### 5501 Behavioral Biology

**21140 (EGG—10282-2134) Differential response of coyotes to novel stimuli in familiar and unfamiliar environments.** Harris, C.E.; Knowlton, F.F. (EG and G Energy Measurements, Inc., Goleta, CA (USA). Santa Barbara Operations; Denver Wildlife Research Center, CO (USA); Utah State Univ., Logan (USA)). 1986. Contract AC08-83NV10282. 21p. NTIS, PC A03. File Number DE87005821.

The behavioral responses shown by captive coyotes, Canis latrans, to novel objects and artificial scent stations in familiar and unfamiliar environments were studied to determine how coyotes potentially respond to novel stimuli used in coyote management and research. Coyotes showed little avoidance of novel objects and scent stations when they were encountered in unfamiliar environments while avoidance was frequently observed with the same stimuli encountered in familiar environments, and supported the hypothesis that coyotes are more vulnerable to trapping and man-induced mortality when outside of the familiar environment of their territories.

### 5502 Biochemistry

*REFER ALSO TO CITATION(S) 21166, 21213, 21214, 21215, 21216, 21217, 21218, 21219, 21220*

**21141 (AD-A—175476/1/XAB) Synthesis of radiolabeled mycotoxins. Annual report, 1 December 1984-1 December 1985.** Kraus, G.A. (Iowa State Univ. of Science and Technology, Ames (USA)). Jan 1986. 5p. NTIS, PC A02/MF A01.

The primary goal of this research is to apply chemistry developed in the author's research group to the synthesis of labeled T-2 toxin and T-2 tetrol. In order to optimize the chances for reaching the goal, the research effort was split into two parts. In one part, a route had previously been successful for the total synthesis of calonectrin was modified. In the other part, a new and potentially much shorter route to T-2 toxin was explored. Neither route has yet been completed. The route to calonectrin should be readily amended for the synthesis of T-2 toxin. An improvement of the original synthetic route that would have shortened it by five steps is illustrated.

**21142 (CONF-8608155—1) Effect of surface and membrane potentials on IAA [indoleactic acid] uptake and binding by zucchini membrane vesicles.** Clark, K.A.; Goldsmith, M.H.M. (Yale Univ., New Haven, CT (USA). Dept. of Biology). Aug 1986. Contract FG02-85ER13337. 10p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003222.

From NATO Advanced workshop on plant hormone receptors; Bonn, F.R. Germany (18 Aug 1986).

The polar transport of the endogenous hormone controlling extension growth of plant cells, indoleacetic acid (IAA), is thought to depend on transmembrane pH and electrical gradients resulting in part from the action of proton ATPases in the plasma membrane. Elements of this transport process are permeation of the membrane by the undissociated lipophilic indoleacetic acid (IAAH) from the acidic apoplast, followed by dissociation of the weak acid and accumulation of the IAA anion ($IAA^-$) in the alkaline cytoplasm; a saturable symport of $IAA^-$ with one or more protons; a carrier-mediated efflux of $IAA^-$ down a considerable electrochemical gradient. The efflux is greater from the basal than the apical end of cells and is thought to be responsible for the overall polarity of the process. This step is also the site of action of napthylphthalamic acid (NPA) and herbicides that inhibit polar transport but stimulate net accumulation of auxin by tissues and cells. We are using membrane vesicles as a simplified system for studying the mechanisms involved in the transport and accumulation of auxin. In particular, we are interested in determining the involvement of the transmembrane pH (pH/sub o/ < pH/sub i/) and voltage gradients ($K^+$ diffusion potential, [$K^+$]/sub in/ > [$K^+$]/sub out/) in IAA uptake. 19 refs., 6 figs.

**21143 (CONF-8609239—1) Detection and characterization of point mutations by two-dimensional gel electrophoresis.** Giometti, C.S.; Zhang, J.S. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004648.

From Electrophoresis '86: 5th meeting of the International Electrophoresis Society; London, UK (9 Sep 1986).

Two-dimensional gel electrophoresis (2DE) is a valuable tool for the detection of point mutations expressed as charge-shift variants in protein patterns. The ability to do subsequent 2DE mapping of peptides from the variant protein compared to the "wild-type" protein allows identification of peptide fragments that contain the actual amino acid substitution. The appropriate peptides can then be extracted from gels and used for amino acid sequencing. The nature of the DNA alteration that gave rise to the mutant protein may be obvious from the amino acid difference between the variant and normal protein, or the amino acid sequence could be used to syntheisze gene probes to be used in DNA sequencing. The system of 2DE can thus be used to both detect a mutation and provide information on the structural changes that give rise to altered protein patterns. 8 refs., 2 figs., 1 tab.

**21144 (DOE/ER/10637—T4) The bioenergetics of salt tolerance: Final report (1).** Packer, L. (California Univ., Berkeley (USA). Dept. of Physiology-Anatomy). 28 Oct 1986. Contract AS03-80ER10637. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006649.

Studies on the sequence of events that lead to salt adaptation in the cyanobacterium Synechococcus 6311 are reported. We present here our major findings on how this freshwater organism responds to a transition from low salt (12 M NaCl) to high salt (0.5 M NaCl) medium; we have studied immediate and long-term osmotic responses, identified deleterious effects of NaCl on cellular processes, and analyzed adaptations of the bioenergetic systems that permit Synechococcus 6311 to tolerate a high salt environment. We have also developed new electron spin resonance (ESR) methods for measuring intracellular $O_2$ concentrations and intracellular pH. These new methods will continue to be of great value in our future studies on the bioenergetics of salt tolerance. 26 refs.

21145 **(DOE/ER/10637—T5) The bioenergetics of salt tolerance: Final report (2).** Lanyi, J.K. (California Univ., Irvine (USA). Dept. of Physiology and Biophysics). 28 Oct 1986. Contract AS03-80ER10637. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006650.

Studies on the physiology and molecular mechanism of light-driven chloride transport by halorhodopsin in the halobacteria are described. These studies focus on the ion-transport ATPase of halobacteria and the respiration-linked sodium transport system of the halotolerant bacterium, Bal. The results have provided insights into the role and functioning of ionic pumps. Chloride transport was shown to be an integral component of the overall ion circulation in halobacterial cells, one which maintains internal salt concentration and therefore cellular volume. A considerable amount of new information was gained about how halorhodopsin functions: its photointermediates, the nature of chloride-binding sites, the role of the deprotonation of the retinal Schiff-base, and how removal of most of the arginine residues affects (or rather, not affects) chloride-binding. Methods were adapted and developed for the study of membrane-bound halobacterial ATPase, its solubilization and (so far) partial purification. It was shown that in the salt-tolerant pseudomonad, Bal, the sodium-sensitive step in the respiratory chain is at the reduction of the semiquinone to quinol, as in another unrelated, but also salt-tolerant, marine microorganism. 17 refs., 1 fig.

21146 **Kinetic modeling of receptor-ligand binding applied to positron emission tomographic studies with neuroleptic tracers.** Logan, J.; Wolf, A.P.; Shiue, C.Y.; Fowler, J.S. (Brookhaven National Lab., Upton, NY). *Journal of Neurochemistry;* No. 1, 73-83(Jan 1987).

Positron emission tomography (PET) with labeled neuroleptics has made possible the study of neurotransmitter-receptor systems in vivo. In this study we investigate the kinetics of the 3,4-dihydroxyphenylethylamine (dopamine) receptor-ligand binding using PET data from a series of experiments in the baboon with the $^{18}$F-labeled drugs spiperone, haloperidol, and benperidol. Models used to describe these systems are based on first-order kinetics which applies at high specific activity (low receptor occupancy). The parameters governing the uptake and loss of drug from the brain were found by fitting PET data from regions with little or no receptor concentration (cerebellum) and from experiments in which specific binding was blocked by pretreatment with the drug (+)-butaclamol. Receptor constants were determined by fitting data from receptor-containing structures. Correcting the arterial plasma activities (the model driving function) for the presence of drug metabolites was found to be important in the modeling of these systems.

21147 **Biosynthetic preparation of L-[$^{13}$C]- and [$^{15}$N]glutamate by Brevibacterium flavum.** Walker, T.E.; London, R.E. (Los Alamos National Lab., NM). *Applied and Environmental Microbiology;* **53**: No. 1, 92-98(Jan 1987).

The biosynthesis of isotopically labeled L-glutamic acid by the microorganism Brevibacterium flavum was studied with a variety of carbon-13-enriched precursors. The purpose of this study was twofold: (i) to develop techniques for the efficient preparation of labeled L-glutamate with a variety of useful labeling patterns which can be used for other metabolic studies, and (ii) to better understand the metabolic events leading to label scrambling in these strains. B. flavum, which is used commercially for the production of monosodium glutamate, has the capability of utilizing glucose or acetate as a sole carbon source, and important criterion from the standpoint of developing labeling strategies. Unfortunately, singly labeled glucose precursors lead to excessive isotopic dilution which reduces their usefulness. Studies with [3-$^{13}$C]pyruvate indicate that this problem can in principle be overcome by using labeled three-carbon precursors; however, conditions could not be found which would lead to an acceptable yield of isotopically labeled L-glutamate. In contrast, [1-$^{13}$C]- or [2-$^{13}$C]acetate provides relatively inexpensive, readily available precursors for the production of selectively labeled, high enriched L-glutamate. The preparation of L-[$^{15}$N]glutamate from [$^{15}$N]ammonium sulfate was carried out and is a very effective labeling strategy. Analysis of the isotopic distribution in labeled glutamate provides details about the metabolic pathways in these interesting organisms.

21148 **Electron diffraction analysis of the M412 intermediate of bacteriorhodopsin.** Glaeser, R.M.; Baldwin, J.; Ceska, T.A.; Henderson, R. (Lawrence Berkeley Lab., Berkeley). *Biophysical Journal;* No. 5, 913-920(Nov 1986).

High resolution electron diffraction data have been recorded for glucose-embedded purple membrane specimens in which bacteriorhodopsin (bR) has been trapped by cooling slowly to below–100 degrees C under continuous illumination. Thin films (OD approximately 0.7) of glucose-embedded membranes, prepared as a control, showed virtually 100% conversion to the M state, and stacks of such thin film specimens gave very similar x-ray diffraction patterns in the bR568 and the M412 state in most experiments. To be certain that any measured differences in diffraction intensity would be real, two independent sets of electron diffraction intensities were recorded for near-equatorial, i.e. (hkO), reflections. Little correlation was indeed observed between these two sets for delta F values at low resolution (15-5.0 A, 49 reflections), but the correlation coefficient is approximately 0.3 at high resolution (5.0-3.3 A, 218 reflections). Thus, while most of the measured difference is error, the mean delta F and the correlation coefficient can be used to estimate the smaller, true delta F due to structural changes occurring in the M state. The magnitude of this estimated true mean delta F is equal to what would be produced if approximately five to seven nonhydrogen atoms were moved to structurally uncorrelated (i.e., new) positions in the M state. Movements of a few amino acid side chains, and repositioning of atoms of the retinal group and the associated lysine side chain after trans-cis isomerization, are the most probable causes of the observed intensity changes in the M state.

21149 **The unfolding of a catalytic mechanism for the remarkable ATP synthase.** Melese, T. (Univ. of California, Los Angeles, CA). pp 511-524 of Recent advances in biological membrane studies. Packer, L. New York, NY; Plenum Press (1985). (CONF-8408201—).

From NATO advanced study institute on new developments and methods in membrane research and biological energy transduction; Spetsai, Greece (16 Aug 1984).

This paper explains how energy is used to drive ATP synthesis. A schematic illustration of oxidative phosphorylation is presented and the active site of the ATP synthase is shown. The energy-linked change mechanism is shown with three catalytic sites participating. One of the important pieces of data for cooperativity between subunits is discussed and it concerns the retention at the catalytic site of 1 mole of ADP per mole of enzyme when ATP is being hydrolyzed at concentrations far below that required for half-maximal velocity.

21150 **Repair of α- or X-radiation-induced DNA damage in cultured human skin fibroblasts.** Chen, D.J.; Bingham, J.M.; Strniste, G.F. (Genetics Group, Life Sciences Div., Los Alamos National Lab., Los Alamos, NM). pp 118 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

The authors previously reported the RBE for cell killing and mutagenicity at the hgprt locus in cultured human skin fibroblasts (GM10) was 7 and 13-18, respectively, for high-LET /sup 238/Pu-emitted α-particles compared to low-LET 250 kVp X-rays. Dose fractionation studies indicated repair of sublethal and mutational damages in X-irradiated cells, whereas, this repair was not observed in cells exposed to α-radiation. In this report, the agents present data on radiation-induced DNA single-strand and double-strand breaks (ssb and dsb) and their repair in both proliferating and confluent monolayers of GM10 cells. Employing sensitive alkaline and neutral DNA filter elution analyses, rates of ssb induced by X-rays were 6-fold that observed for α-particles, whereas rates of dsb induced by α-particles were 2.4-fold greater than those induced by X-rays. Rejoining the ssb induced by either radiation was rapid and >90% were repaired within 60 min post-irradiation incubation at 37°. The time necessary for 50% repair (t/sub 1/2/) of X-ray-induced dsb was —40 min, however, for —-irradiated cells (20-110 Gy) the t/sub 1/2/ was 4-8-fold greater. Even after prolonged post-irradiation incubation (48 hr) using confluent GM10, —30% dsb re-

mained unrepaired. This class of unrepaired DNA lesions probably contributes to the elevated RBE for high-LET radiation.

21151 **Development of a defined-sequence DNA system for use in DNA misrepair studies.** Sutton, S.; Tobias, C.A. (Biology and Medicine Div., Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). pp 119 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

The authors have developed a system that allows them to study cellular DNA repair processes at the molecular level. In particular, the authors are using this system to examine the consequences of a misrepair of radiation-induced DNA damage, as a function of dose. The cells being used are specially engineered haploid yeast cells. Maintained in the cells, at one copy per cell, is a cen plasmid, a plasmid that behaves like a functional chromosome. This plasmid carries a small defined sequence of DNA from the E. coli lac z gene. It is this lac z region (called the alpha region) that serves as the target for radiation damage. Two copies of the complimentary portion of the lac z gene are integrated into the yeast genome. Irradiated cells are screened for possible mutation in the alpha region by testing the cells' ability to hydrolyze xgal, a lactose substrate. The DNA of interest is then extracted from the cells, sequenced, and the sequence is compared to that of the control. Unlike the usual defined-sequence DNA systems, theirs is an in vivo system. A disadvantage is the relatively high background mutation rate. Results achieved with this system, as well as future applications, are discussed.

21152 **Intracellular repair of DNA strand breaks in higher cells: Current status of viral probe studies using SV40.** Krisch, R.E.; Tan, P.M. (Dept. of Radiation Therapy, Univ. of Pennsylvania School of Medicine, Philadelphia, PA 19104). pp 120 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

The authors have been developing an alternative experimental approach to the study of intracellular repair of DNA strand breaks and lesions convertible to strand breaks by higher cells, based on the use of SV40 virus, which lacks intrinsic DNA repair capacity, as an intracellular test molecule or probe. This approach involves a combination of gel electrophoresis for separation of several classes of damaged viral DNA molecules and DNA hybridization for detection and quantitation of these molecules. Previously reported preliminary experiments with isolated nuclei from CV-1 monkey kidney cells indicated that this approach can demonstrate slow but extensive intracellular repair of single strand DNA breaks (SSB) and more limited repair of double strand DNA breaks (DSB), with considerable experimental variability. The current investigations are focussing on the kinetics of observed DNA repair, the sources of experimental variability, and on additional control experiments. This information is being used to assess the comparability of DNA strand break repair as measured by the authors viral probe approach with DNA repair as measured by more traditional and widely used methods.

## 5503 Cytology

*REFER ALSO TO CITATION(S) 21198, 21220*

## 5504 Genetics

*REFER ALSO TO CITATION(S) 21195, 21197*

21153 **(DOE/ER/13377—2) Genomic variation in maize: Annual progress report.** Rivin, C.J. (Oregon State Univ., Corvallis (USA)). [1987]. Contract FG06-85ER13377. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87006031.

In previous experiments, rapid quantitative changes were observed in specific sequences took place in F1 hybrids of inbred maize lines. One of our major goals is to understand how and when such changes occur, and how stable the novel multiplicities are in subsequent generations. 3 figs., 2 tabs.

## 5505 Metabolism

*REFER ALSO TO CITATION(S) 21183, 21196, 21197*

21154 **Removal of α-tocopherol from blood and its comparison with other lipids.** Gardner, H.K.; Vang, M.J.; Mavis, R.D. (Univ. of Rochester, NY). *Federation Proceedings, Federation of American Societies for Experimental Biology;* **45**: No. 4, 841(1986). (CONF-8604222—).

From 70. annual meeting of the Federation of American Society for Experimental Biology; St. Louis, MO, USA (13 Apr 1986).

The blood decay curve of α-tocopherol in rats was compared with those of the two major blood lipids by labeling rat serum in vitro with $^3$H-α-tocopherol (AT), $^3$H-cholesterol (CHO) or $^3$H-trioleoylglycerol (TO) and injecting it into the bloodstream. For the three lipids, loss from blood was biphasic. The half time of the faster decay was 2-4 minutes. The slower curve decayed with half times of 42, 289 and 990 minutes for TO, AT and CHO, respectively. This intermediate rate of AT removal is consistent with its accompanying both of the major blood lipids as they are removed by their respective mechanisms or with a process specific for AT. To investigate the role of liver in the faster curve, animals were hepatectomized. TO and CHO loss remained biphasic after liver removal. However, AT loss became monophasic, with a loss rate intermediate between the non-hepatectomized fast and slow decays. This demonstrates a central role for liver in the metabolism of blood-borne AT and a mode of removal distinct from the other two lipids.

21155 **Radiocarbon labeled fully deuterated glucose: Preparation, chromatography and preliminary distribution studies.** Gatley, S.J.; Wess, M.M.; Govoni, P.L.; Wagner, A.; Katz, J.J.; Friedman, A.M. (Chemistry Dept., Argonne National Lab., IL). *Journal of Nuclear Medicine;* **26**: No. 5, 127(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

Since carbon-deuterium bonds are harder to break than carbon-hydrogen bonds, substitution of deuterium into organic molecules often leads to alterations in metabolism; e.g. fully deuterated glucose (d/sup 7/-G or deuterioglucose) is a poorer substrate than (protio) glucose for the bacterial enzyme, glucose oxidase. Radiolabeled d/sup 7/-G was therefore prepared to search for a possible isotope effect in its biodistribution in mammals. Green algae grown in deuterium oxide for many generations were exposed to C-14 CO/sub 2/ in the light, and then boiled in 2N-HCl. After rotary evaporation of the HCl the residue was passed through H/sup +/- form and CO/sub 3//sup =/-form Dowex columns in water and then passed through silica gel and activated charcoal in ethanol. The major component of the final neutral fraction, d/sup 7/-G was further purified by HPLC on a Bio-Rad HPX-87P column eluted with water. The behavior of d/sup 7/-G on HPX-87P, on an NH-column (Alltech) and on 2D cellulose TLC, was identical with that of glucose. However, on silica gel TLC d/sup 7/-G ran more slowly (R/sub Glc./ = 0.93); this result was confirmed with authentic d/sup 7/-G. In later work, pure C-11 and C-14 d/sup 7/-G were rapidly and conveniently obtained by HPX-87P chromatography of an invertase-treated extract obtained by boiling algae in 80% EtOH. Preliminary tissue distributions and metabolite analyses suggest slow transport of d/sup 7/-G than G into the brain. Exploitation of deuterium isotope effects could become a useful aspect of radiopharmaceutical design.

21156 **Modification and spin labeling studies of membrane bioenergetics.** Packer, L.; Mehlhorn, R.J. (Univ. of California Berkeley, CA). pp 75-96 of Recent advances in biological membrane studies. Packer, L. New York, NY; Plenum Press (1985). (CONF-8408201—).

From NATO advanced study institute on new developments and methods in membrane research and biological energy transduction; Spetsai, Greece (16 Aug 1984).

This paper uses chemical modification techniques, alone and in combination with nitroxide spin probes, to study biological energy converters, emphasizing light-energized systems with relatively simple structures. The principal research objective is to elucidate the molecular mechanisms of energy conversation by photocatalysts. Bacteriorhodopsin has been the primary focus of the research program; but the authors recently initiated some studies with bacterial chromatophores, which contain only photosystem I, but not the water-splitting photosystem II of higher plants.

## 5506 Medicine

*REFER ALSO TO CITATION(S) 20147, 20732, 21013, 21146, 21204, 21212*

21157 **(AD-A—174983/7/XAB) Variance functions and the minimum detectable concentration in assays. Technical report, August 1985-August 1986.** Carroll, R.J.; Davidian, M.; Smith, W. (North Carolina Univ. at Chapel Hill (USA). Inst. of Statistics). Jul 1986. 36p. (MIMEO-SER—1701). NTIS, PC A03/MF A01.

Assay data are often fit by a nonlinear regression model incorporating heterogeneity of variance, as ion radioimmunoassay, for example. Typically, the standard deviation of the response is taken to be proportional to a power theta of the mean. There is considerable empirical evidence suggesting that, for assays of a reasonable size, how one estimates the parameter theta does not greatly affect how well one estimates the the mean regression function. An additional component of assay analysis is the estimation of auxiliary constructs such as the minimum detectable concentration, for which many definitions exist; focus here is on one such definition. The minimum detectable concentration depends both on theta and the mean regression function. Three standard methods of estimating the parameter theta are compared. When duplicate counts are taken at each concentration, the first method is only 20% efficient asymptotically in comparison to the third, and the resulting estimate of the minimum detectable concentration is asymptotically 3.3 times more variable for first than the third. Less-dramatic results obtain for the second estimator compared to the third; this estimator is still not efficient, however. Simulation results and an example are supportive of the asymptotic theory.

21158 **(BMI—1985-097) Efficacy of diagnostic irradiation in paediatry. 1. report (December 1984). Final report.** Fendel, H.; Schneider, K.; Bakowski, C.; Kohn, M.M. (Bundesministerium des Innern, Bonn (Germany, F.R.)). Dec 1985. 137p. (In German). NTIS (US Sales Only), PC A07/MF A01. File Number DE87751287.

Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten.

This first report starts with a definition of the term and concept of 'efficacy', given by the project leader Mr. H. Fendel. The following six individual papers deal with various aspects of the subject matter, followed by an outlook on future tasks. In the appendix the letter sent to physicians asking for support of the project, and the forms are added.

21159 **(GSF—31/85) Experimental tumour treatment. Report 1984 on the cooperation between the Institute of Radiobiology of Muenchen University and the Department of Radiobiology of the Society for Radiation and Environment Research, Neuherberg.** (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.)). Aug 1985. 122p. (In German). (GSF-B—1821). NTIS (US Sales Only), PC A06/MF A01. File Number DE87751289.

This report of 1984 is the seventh in a series and presents that year's results of continuous studies in the domain of experimental tumour radiotherapy. In the year under review, more personnel has been available for the studies, and the scientific programmes for the assessment of acute and chronic side effects of radiotherapies have been extended. New models have been developed, among them a first system based on animal experiments, for quantifying the mucositis of the oral and pharyngeal mucosa, a limiting condition in the radiotherapy of head and throat tumours. Another significant advancement is a model for quantification of chronical damage to the ureter, which still is a serious problem in the radiotherapy of gynaecological tumours. The 1984 experimental tumour studies have been mainly devoted to the repopulation and split-dose recovery in various tumours, concentrating on dose fractionation as one of the major problems studies. Particular interest has been attached to the processes involved in treatments over several weeks with a daily effective dose of 2 Gy.

21160 (IA—1421, pp 158-159) **New method for in vitro labelling of red blood cells.** Trumper, U.; Weininger, J. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21161 (IA—1421, pp 161) **New Os-191/Ir-191m generator for first-pass radionuclide angiography.** Issachar, D.; Trumper, J.; Braun, A.; Abrashkin, S. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21162 (IA—1421, pp 164) **Cardiac studies on dogs using Ir-191m.** Helman, C.; Lubin, E.; Trumper, J.; Abrashkin, S.; Braun, A.; Issachar, D. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21163 **(INIS-mf—10562) Clinical dosimetry for different accelerators used in theory: choice of detectors.** (Commissariat aux Energies Nouvelles, Algiers (Algeria). Centre d'Etudes Nucleaires et Solaires). Jun 1986. 100p. (In French). NTIS (US Sales Only), PC A05/MF A01. File Number DE87701463.

The work described in this thesis deals in the first part with the initial dosimetry work which has to be accomplished when receiving a linear accelerator for use in therapy. We worked with the "MEVATRON" (8MV photons) in a water phantom, using ionisation chambers. The obtained measurements, including the isodose curves, have been compared to the isodoses calculated by the program SIDOS-UI with the method of decrement lines and the matricial method. The matricial method has shown to be the most accurate. In the second part, we emphasize an "in vivo" application. For this purpose, we study the variation of the sensitivity of the thermoluminescent dosimeter 7 Lif in clinical beams of fast neutrons. The results are presented and discussed.

21164 **(IPEN-Pub—84) Insulin radioimmunoassay kit prepared by IPEN-CNEN/SP - Brazil. Technical specifications.** (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). Nov 1985. 22p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700934.

The specification and methodological aspects of the insulin radioimmunoassay kit produced by IPEN-CNEN/SP - Brazil are described. The limitations taking care and the following quality control parameters or procedures are discussed: specific radioactivity, comparison between two insulin - /sup 125/I purification procedures, affinity constant 'K' of the antigen - antibody reaction, minimal detectable dose (MDD), kinetics degradation of the radioinsulin, radioassay imprecision profile, radioassay performance temperature dependence and normal values histogram.

21165 **Scanning Soft X-Ray Microscopy at the Brookhaven Light Source.** Kirz, J. (Suny at Stony Brook, Stony Brook, NY). pp 251-264 of Examining the submicron world. Feder, R.; McGowan, J.W.; Shinozaki, D.M. New York, NY; Plenum Press (1986). (CONF-8407185—).

From 1. international seminar on the role of data and judgement in probabilistic risk analysis; Brussels, Belgium (26 Aug 1985).

This paper presents reasons why the author chose to construct a scanning microscope and a reasonable detailed description of the apparatus is given. An examination of the author's experience

with imaging and microanalysis is presented and plans for future improvements are discussed. The image of a diatom is shown which illustrates the ability of the microscope to image wet specimens; internal features of the organism are clearly visible. Another image illustrates the ability of the instrument to ""zoom" by changing the step size in the scan; the object is a pair of chromosomes, shown at three levels of magnification.

21166 **Synthesis and biodistribution of [C-11] labeled irreversible inhibitors of MAO A and B.** MacGregor, R.R.; Halldin, C.; Fowler, J.S.; Wolf, A.P.; Alexoff, D.; Arnett, C.D.; Langstrom, B. (Chemistry Dept., Brookhaven National Lab., Upton, NY). *Journal of Nuclear Medicine;* **26**: No. 5, 37(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

Alterations in the enzyme monoamine oxidase (MAO) have been implicated in a number of diseases. Two types of MAO (A and B) have been identified by their substrate selectivity as well as their selective inhibition by the propargyl amines clorgyline (la) and L-deprenyl (lb). These inhibitors, which are substrates for MAO A and B respectively, deactivate the enzyme by becoming covalently or irreversibly attached to it, and so, if labeled with a positron emitter may provide selective probes for MAO localization and reactivity in vivo using PET. N-[C-11]methyl 1a and 1b have been synthesized. Synthesis time was 40 min with a radiochemical yield (EOB) of $\approx$ 20% and a specific activity of $\approx$ 200 mCi/$\mu$mole (EOB). Differences in tissue distribution between control and 1a and 1b in pretreated mice demonstrated specific uptake and retention of each of these tracers to organs known to contain the specific MAO subtype. Centrifugation of brain homogenates showed selective binding of activity to particulate material following protein precipitation. The results support the premise of specific irreversible binding in vivo of 1a to type A and 1b to type B MAO and demonstrate the feasibility of using this approach for probing functional enzyme activity in vivo using PET.

21167 **Considerations in the radioiodination and chelation labeling of an antiplatelet monoclonal antibody.** Srivastava, S.C.; Meinken, G.E.; Scudder, L.E.; Coller, B. (Brookhaven National Lab., Upton, NY). *Journal of Nuclear Medicine;* **26**: No. 5, 45(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

Radiolabeling of antibodies in particular with iodine nuclides frequently alters their biological behavior and compromises the specificity of binding to the in vivo antigens. Sensitivity to labeling chemistry however, is quite variable for different antibodies. This study was carried out to investigate the various factors affecting the binding to platelets (P) of an anti-P monoclonal antibody, 7E3, following iodination with I-123, I-125, I-131 and chelation labeling with In-111 and Tc-99m. Parameters such as the nature and amount of oxidant, reaction times, substitution level, specific activity etc., were studied. Results showed that each factor in addition to affecting chemical labeling yields also affected the binding of labeled 7E3 to P in whole blood and their blood clearance and clot uptake. With increasing I/7E3 or DTPA/7E3 molar ratios, a progressive decrease in binding to P resulted. Chloramine T (5-10 $\mu$g/100 $\mu$g 7E3) was superior to other oxidizing agents but the reaction times had to be $\leqq$2 min (labeling yields 70 +- 10%). 7E3 appeared unaffected by specific activities of up to 40 $\mu$Ci/$\mu$g (I-131 and In-111) and 300 $\mu$Ci/$\mu$g (I-123). Satisfactory In-111-, I-131-, or I-123-7E3-P preparations were obtained that show considerable promise for localizing in vivo thrombi. Results of this study and prior experience with other antibodies indicate that in order to achieve maximum efficacy in imaging or therapy applications, individual antibodies may require a careful optimization of labeling procedures with different radionuclides.

21168 **Effect of chloramine-T labeling conditions on the stability of monoclonal antibodies and their fragments.** DeNardo, G.L.; DeNardo, S.J.; Miyao, N.P.; Peng, J.S.; Epstein, A.L.; Cardiff, R.D. (Univ. of California, Davis Medical Center, Sacramento, CA). *Journal of Nuclear Medicine;* **26**: No. 5, 45(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

Rapid in vivo degradation of radioiodinated monoclonal antibodies (MAb) has been reported. Conditions for radioiodination have varied. The purposes of this study were to compare the stability of MAb and their fragments when iodinated with chloramine-T (CT) under different conditions, and to compare methods for quality assessment of the radioiodinated molecules. A B-cell lymphoma MAb (Lym-1, IgG2a) and its FAb fragment, and a mammary cancer MAb(B6.01, IgG1) and its F(Ab')/sub 2/ fragment were iodinated with I-125 at CT:AB and I:Ab ratios of 1:1 and 1:10. Molecular sieving (TSK-3000) high performance liquid chromatography (HPLC), cellulose acetate electrophoresis (CAE) at 11 and 45 minutes and solid phase immunoreactivity (IRA) were used to observe stability of the molecules when stored at 4°C. Radiochemical yield was greater than 95% in all instances. Iodination at CT:Ab and I:Ab ratios of 1:1 induced progressive degradation in all species which was most marked for the fragments. Iodination at CT:Ab and I:Ab ratios of 1:10 resulted in no observable degradation over 21 days. There was no significant difference in degradation between the IgG2a and IgG1 antibody when iodinated under identical circumstances. HPLC, CAE for 11 minutes and IRA, but not CAE for 45 minutes, revealed comparable changes. The authors conclude that lesser amounts of chloramine-T can be used to iodinate MAb and their fragments without loss of radiochemical efficiency and with improved stability of the species. MAb fragments are more vulnerable to chloramine-T. These observations may explain, at least in part, rapid in vivo degradation of radioiodinated MAb.

21169 **Comparison of three boundary detector methods for SPECT.** Macey, D.J.; DeNardo, G.L.; DeNardo, S.J. (Univ. of California Davis Medical Center, Sacramento, CA). *Journal of Nuclear Medicine;* **26**: No. 5, 51(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

An important objective for accurate attenuation compensation in quantitative SPECT is information on the boundary of the transverse section. The usual ellipse drawn to approximate sections of the brain does not adequately describe the boundary of sections of the body. The objective of this study was to compare the performance of three methods that can define the boundary using scattered photons from a radionuclide source. Three source geometries studied were (i) multiply scattered photons from an internal source in the section (ii) 90° Compton scattered photons from an external collimated source fixed to the gamma camera (iii) Backscattered photons from an external source fixed to the edge of the collimator. For each geometry an appropriate energy window was used for 360° acquisition of 64 images of a thorax phantom. Transverse section images were reconstructed as used for emission SPECT. These section images were smoothed and a threshold used to find the integrity of the boundary. An important advantage of these scatter methods is they can provide, with a single 360° rotation over 10 minutes, individual boundaries of multiple transverse sections that cover a large area of the body. The 90° Compton scatter method using a collimated radionuclide source of Tc-99m was found to give the best definition of the boundary, the backscatter method provided the next best definition. The contour of the final transverse section image was found to be clearly defined and the size of phantom could be determined to 6 mm with the 90° scatter method.

21170 **Radioimmunoimaging of experimental thrombi in dogs using Tc-99m labeled monoclonal antibody fragments [MAPab-F(ab')/sub 2/] reactive with human platelets.** Som, P.; Oster, Z.H.; Yamamoto, K.; Sacker, D.F.; Brill, A.B.; Zamora, P.O.; Newell, K.D.; Rhodes, B.A. (Brookhaven National Lab., Upton, NY). *Journal of Nuclear Medicine;* **26**: No. 5, 5(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

Radioimmunoimaging of thrombi could have great clinical value in the management of coronary artery and thromboembolic disease. In-111-oxine-labeled platelets currently used require platelet isolation, delayed imaging, background subtraction and there is also potential for damaging or contaminating platelets during labeling. Murine monoclonal antibody (IgG/sub 2/a) fragments directed against human platelet membrane components (cross-reactive with dog platelets) were labeled with Tc-99m and repurified from "kits".

After radiolabeling, 91.5-93.3% of the Tc-99m was antibody-associated. The preparations retained immunoreactivity, as determined by the ratio of cell to plasma-associated radioactivity (ratios 54.7-63.8). Tc-99m-MAPAb-F(ab')/sub 2/ were injected i.v. into dogs with thrombi produced in peripheral and pulmonary veins and arteries. About 50% of the radioactivity was cleared from the blood in 3-6 min. and 18-24% was excreted in the urine within 3 hrs. The thrombi were consistently and easily visible within 1-3 hrs. with no need for blood pool subtraction. In some cases, intimal damage along the path of catheters was seen. No adverse side effects were observed. The advantages of this method are: short and simple preparation, no need for blood pool subtraction and early visualization of thrombi. Human studies are warranted to determine its clinical efficacy.

21171 **A new osmium-191/iridium-191m generator system.** Brihaye, C.; Knapp, F.F. Jr.; Butler, T.A.; Guillaume, M. (Nuclear Medicine Group, Oak Ridge National Lab., Oak Ridge, TN). *Journal of Nuclear Medicine;* **26**: No. 5, 27(May 1985). (CONF-850611—). Contract AC05-84OR21400.

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

Ir-191m (t1/2 4.96 sec) has very attractive properties for radionuclide angiography and is obtained from the long-lived (15 d) Os-191 parent. Because of the long parent half-life, generators could have an extended shelf-life (2-3 weeks) if the problems of low Ir-191m yields and rapidly increasing Os-191 breakthrough could be overcome. A new /sup 191/Os//sup 191m/Ir generator system has now been developed involving adsorption of K/sub 2/OsCl/sub 6/ (Os-IV) on heat-treated (800°C) activated coconut carbon. This system gives consistently good Ir-191m yields of ≈35-40% for a 5 ml bolus and low Os-191 breakthrough of ≈1x10/sup -4/% bolus over a 2-3 week period. In addition, this simple system does not require a scavenger column and no radiolysis has been detected after loading up to 1 Ci of Os-191. The generator is prepared from 140-230 mesh carbon and eluted with pH 2 - 0.9% NaCl containing 0.025% KI. The use of KI in the eluting solution is critical for generator performance. Yield and breakthrough do not change for up to 250 elutions of the prototype system. The generator eluent is neutralized to physiological pH and isotonicity with 0.13 M Tris buffer immediately prior to intravenous injection. No adverse effects have been observed in studies in normal adult volunteers. This system has a long shelf-life and represents a simple, readily available source of Ir-191m for radionuclide angiography.

21172 **Dead time correction and counting statistics for positron tomography.** Roos, M.S.; Mazoyer, B.M.; Huesman, R.H.; Budinger, T.F. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA). *Journal of Nuclear Medicine;* **26**: No. 5, 36(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

A correction for loss of events due to dead time in dynamic positron emission tomography is presented. The correction is applied to projection data and to region of interest analysis of dynamic PET studies. Formulae for the covariances between corrected projection data and between counts in regions of interest in different images from the same dynamic study are established and verified experimentally. The model employs a paralyzing dead time to describe the behavior of a tomograph over the range of event rates normally encountered in patient studies (up to 200,000 events/sec/detector layer). The Donner 280-Crystal Positron Tomograph is characterized by a dead time of 1.8 μsec/event for observed count rates of less than 200,000 events/sec. The dead time correction factor is 1.8 at 180,000 events/sec. At 180,000 events/sec, the variance of the actual (corrected) number of events in a region containing 3.34 x 10/sup 5/ actual events is predicted from the model to be 3.86 x 10/sup 6/ events/sup 2/, which is more than 10 times the variance that would be expected assuming Poisson statistics. The predictions are verified by observing a Ge-68 source (half-life 282 days) and a F-18 source (half-life 110 min) simultaneously. The necessity and importance of dead time correction in dynamic PET is illustrated for myocardial flow studies in dogs using 0-15 water and Rb-82. An error of 25% in myocardial flow can occur if dead time compensation is not employed.

21173 **P-31-NMR analysis of in vivo metabolic events in lymphoma during RIT.** Adams, D.A.; DeNardo, G.L.; DeNardo, S.J. (Univ. of California Davis Medical Center, Sacramento, CA). *Journal of Nuclear Medicine;* **26**: No. 5, 39(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

Radioimmunotherapy (RIT) is potentially a powerful method for treatment of cancer. The efficacy of radioimmunopharmaceuticals on target tissue were measured serially, in vivo, in the human non-Hodgkin's lymphoma (RAJI tumor) using P-31 surface coil NMR. During application of a pulse dosage at curative levels I-131-labeled monoclonal antibody (Lym-1) specific for this tumor, approximately 10,000 rads were delivered to the tumor and 3,000 to the kidney. ATP/Pi ratios and tissue pH were determined in these tumors during therapy and correlated with tumor volumes and radiation-induced tissue damage. During the course of these experiments, the authors noted that the effects of the radiation dose, calculated to be curative, are non-uniform throughout the tissue mass. Therefore, regions of the sample have been distinguished on the basis of differing magnetization precessional rates around the spatially dependent B/sub 1/ field. Two-dimensional FT processing yielded a metabolite map as a set of spectra deployed as a function of mapping distance from the surface coil. In this fashion, metabolites within the tissue slice can be spatially defined. This noninvasive determination of metabolic function appears useful in characterizing the extent of radiation-induced necrosis, spontaneous recurrence of tumor tissue, and sequential evaluation of various dose modalities. These data will be useful in optimization of human RIT regimens.

21174 **Thrombus detection with a radiolabeled antiplatelet monoclonal antibody: Comparison with In-111-oxine technique in coronary and peripheral thrombi in dogs.** Srivastava, S.C.; Esekowitz, M.D.; Meinken, G.E.; Lange, R.C.; Smith, E.; Carbo, P.; Scudder, L.E.; Coller, B. (Brookhaven National Lab., Upton, NY). *Journal of Nuclear Medicine;* **26**: No. 5, 49(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

Platelets (P) labeled with low concentrations of an I-123 or In-111 labeled anti-P monoclonal antibody (7E3) were shown earlier to successfully image in-vivo thrombi. This study was carried out to compare this technique with In-111-oxine-P for localizing coronary and venous thrombi (CT and DVT) in dogs. Thrombi were induced using either transcatheter placement of a dacron pug, mechanical trauma, or electrocoagulation. 7E3 was labeled with I-131 in 70 +- 10% yield (labeling conditions: 100 μg 7E3; 5 μg chloramine T; I/sup -//7E3 ≦1; 2 min reaction; 200 μl pH 7 phosphate buffer; Sp. act. 10-30 μCi/μg). Binding of I-131-7E3 to dog P was 75 +- 10% after 1 hr incubation with whole blood. The dogs were injected with 0.5 mCi In-111-oxine-P and 1 mCi I-131-7E3-P in quick succession and data (blood clearance and imaging) were collected for 4 hr. In one experiment, DVT were clearly imaged within 10 min and CT in 30-60 min with I-131-7E3-P. In contrast, In-oxine-P required at least 30 min for imaging DVT and CT were only faintly visualized at 3-4 hr. The DVT to blood and CT to blood ratios at 2.4 hr were 16 and 12.3 for I-131-7E3-P and 9.4 and 6.5 for In-111-oxine-P respectively. In these preliminary studies, I-131-7E3-P thus appears to be superior to In-oxine-P for imaging venous and coronary thrombi. Additionally, 7E3 can be labeled with Tc-99m and I-123 for reduced dose and better imaging properties.

21175 **Transport, binding, and uptake kinetics of tin and technetium in the in-vitro Tc-99m labeling of red blood cells.** Straub, R.F.; Srivastava, S.C.; Meinken, G.E.; Richards, P. (Brookhaven National Lab., Upton, NY). *Journal of Nuclear Medicine;* **26**: No. 5, 130(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

These studies were undertaken to define the mechanisms involved in the BNL kit methods for labelling red blood cells (RBC) in vitro with Tc-99m. The studied systems included the widely used method requiring plasma separation prior to incubation of "tinned" cells with pertechnetate, and a newer method that enables

specific labeling of RBC in whole blood and uses chemical inactivation of excess tin in the plasma thus eliminating the need for cell separation prior to the addition of pertechnetate. The following were investigated in depth: 1) kinetics of Sn(II) uptake by RBC using above (stannous citrate) its; 2) kinetics of Tc-99m uptake by "tinned" RBC; 3) role of oxidation and chelation in removal of extracellular Sn(II); 4) effect of plasma and other suspending media; 5) sites of binding of Sn(II) and Tc-99m within the RBC. Only Sn(II), and not Sn(IV), was taken up by RBC. The uptake was initially rapid, then asimtotic at <40% after 30 min. The uptake was irreversible and dependent on tin concentration, citrate concentration, plasma, and temperature. Technetium uptake by tinned RBC in blood exhibited similar kinetics but the asimtote was at >90%. Evidence was found for a plasma-bound Sn(II) species that resists oxidation but is slowly dissociable. Chelants such as EDTA or citrate compete successfully for plasma-bound tin and render it oxidizable. Both Sn(II) and Tc-99m bind predominantly to hemoglobin within the cell. The membrane did not appear to be the limiting factor in uptake rates.

21176 **Synthesis and biodistribution of no-carrier-added [1-/sup 11/C]putrescine.** McPherson, D.W.; Fowler, J.S.; Wolf, A.P.; Arnett, C.D.; Brodie, J.D.; Volkow, N. (Brookhaven National Lab., Upton, NY). *Journal of Nuclear Medicine;* **26**: No. 5, 127(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

Recent studies using [/sup 3/H] and [/sup 14/C]putrescine have demonstrated the feasibility of using [/sup 11/C]putrescine as a selective metabolic tracer both for imaging brain tumors and, with the appropriate tracer kinetic model, for the quantitation tumor growth rate in humans using PET. The development of this new PET method requires, among other things, that the synthesis of the /sup 11/C-putrescine provide the labeled compound in sufficiently high specific activity that the normally low endogeneous levels of the diamine are not perturbed on administration of the tracer. Since a previous method for synthesis of [/sup 11/C]putrescine was not applicable to the NCA synthesis a new synthesis was developed. The synthesis of NCA [1-/sup 11/C]putrescine was based on the Michael addition of [/sup 11/C]cyanide to acrylonitrile followed by reduction of the /sup 11/C-labeled dinitrile with borane-methylsulfide complex. Radiochemical yield was 20%, synthesis time was 50 minutes and specific activity was > 1.4 Ci/$\mu$mol (EOB). This represents the first example of the use of the Michael addition reaction in the synthesis of a C-11 labeled compound. Tissue distribution in normal mice at 5, 30 and 60 minutes showed the expected low uptake in normal brain.

21177 **A new rapid radiobromination via transmetallation for the synthesis of radiobrominated myocardial imaging agents.** Srivastava, P.C.; Knapp, F.F. Jr.; Kabalka, G.W.; Kunda, S.A. (Nuclear Medicine Group, Oak Ridge National Lab. (ORNL), Oak Ridge). *Journal of Nuclear Medicine;* **26**: No. 5, 124(May 1985). (CONF-850611—). Contract AC05-84OR21400.

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

The use of E-vinylmercury bromides as precursors for the preparation of (E,Z)-vinylradiobromides has been investigated. E-iodovinylboronic acids were treated with Hg(OAc)/sub 2/ in THF to give the mercuric acetates, which were converted to the corresponding vinylmercury bromides by reaction with NH/sub 4/Br. Addition of Br/sub 2/ (or Br/sub 2/ + NH/sub 4/ /sup 82/Br) gave instantaneously the (E,Z)-vinylbromides 4 (or [/sup 82/Br]4) analyzed by GLC, NMR and C&H. Coupling of Na-Te-(CH/sub 2/)/sub 3/-COOEt (5) with [/sup 82/Br]4 (n=11) and subsequent hydrolysis gave (E,Z)-18-[/sup 82/Br]bromo-5-tellura-17-octadecenoic acid (6) which was characterized and evaluated in rats. Compound (E,Z)-6 shows uptake and retention similar to the radioiodonated (E) analogue suggesting that the /sup 75/Br- and /sup 76/Br-labeled agents may be good candidates for PET studies.

21178 **Factors affecting the purity of 2-fluoro-2-deoxy-D-glucose (2-FDG) synthesized from the reactions of glycals with acetyl hypofluorite (CH/sub 3/CO/sub 2/F).** Shiue, C.Y.; Wolf, A.P. (Brookhaven National Lab., Upton, NY). *Journal of Nuclear Medicine;* **26**: No. 5, 129(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

The 2-/sup 18/FDG has been synthesized either by nucleophilic substitution with /sup 18/F/sup -/ or by electrophilic fluorination with F/sub 2/ or CH/sub 3/CO/sub 2/F. Recently, there are reports that 2-FDG synthesized from electrophilic fluorination contains 2-fluoro-2-deoxy-D-mannose (2-FDM) as an impurity. The authors report here the steric effects and the solvent effects on the stereoselectivity of the reactions of glycals with CH/sub 3/CO/sub 2/F. Reactions of glycals with CH/sub 3/CO/sub 2/F followed by hydrolysis give 2-FDG and 2-FDM. The ratio of 2-FDG to 2-FDM depends largely on the polarity of the solvent rather than on the size of the substituents on the hydroxyl groups. The amount of 2-FDM in the final product from the reaction of 1B-D glucal with CH/sub 3/CO/sub 2/F ranges from 4% in non-polar solvents (Freon-11, CCl/sub 4/, hexane) to —20% in polar solvents (HOAc, CH/sub 3/OH, DMF, acetone). Therefore, the reaction of CH/sub 3/CO/sub 2/F with glucal in Freon-11 or other non-polar solvents would be the method of choice for the synthesis of 2-/sup 18/FDG.

21179 **Synthesis of $\alpha,\alpha,\alpha$-tri[/sup 18/F]fluorotoluenes.** Angelini, G.; Speranza, M.; Wolf, A.P.; Shiue, C.Y. (Brookhaven National Lab., Upton, NY). *Journal of Nuclear Medicine;* **26**: No. 5, 125(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

F-18 labeled $\alpha,\alpha,\alpha$-trifluorotoluenes (2) are the important intermediates for the syntheses of F-18 labeled radiopharmaceuticals. Compounds (2) (Y=H, O-NH/sub 2/, m-NH/sub 2/, m-OH, p-OH, O-CN, p-CN) have been synthesized by the reactions of benzotrifluoride with K/sup 18/F/18-crown-6 ether in 0-14% yield. The authors report here the syntheses of compounds (2) by the reactions of substituted toluenes with H/sup 18/F/SB/sub 2/O/sub 3/ to give compounds (2) in 0-70% radio-chemical yield depending on the substituents on the aromatic ring and the reaction conditions. This method thus provides a new route to F-18 labeled radiopharmaceuticals which contain $\alpha,\alpha,\alpha$-trifluorotoluene component. For example, 1-($\alpha,\alpha,\alpha$-tri[/sup 18/F]fluoro-m-tolyl)piperazine (3), a serotonin agonist has been synthesized in a 2-step synthesis from m-nitro-$\alpha,\alpha,\alpha$-tri[/sup 18/F]fluorotoluene in 20-30% radiochemical yield.

21180 **Radioiodinated 15-(p-iodophenyl)-3,3-dimethylpentadecanoic acid (DMIPP): A new agent to evaluate regional myocardial fatty acid uptake.** Knapp, F.F. Jr.; Goodman, M.M.; Kirsch, G.; Callahan, A.P. (Nuclear Medicine Group, Oak Ridge National Lab., Oak Ridge, TN 37831). *Journal of Nuclear Medicine;* **26**: No. 5, 123(May 1985). (CONF-850611—). Contract AC05-84OR21400.

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

A new $\beta$, $\beta$-dimethyl-branched fatty acid, 15-phenyl-3,3-dimethylpentadecanoic acid (DMIPP), has been prepared via a 2,5-disubstituted thiophene by the successive Friedal-Crafts acylation/Wolff-Kishner reduction sequence that the authors described earlier. Methyl-branching was introduced using dimethylglutaric acid. Radioiodide was introduced into the para-position by thallation-KI treatment in trifluoroacetic acid. /sup 125/I-DMIPP shows high myocardial uptake in rats (% dose/gm) and also exhibits very slow myocardial wash-out (T/sub 1/2/ = 9 h) and high H:B ratios. This is the first example of a modified fatty acid other than the earlier Te agents that exhibits the unique property of very slow wash-out. /sup 123/IDMIPP is an excellent candidate to study alterations in regional myocardial uptake that may occur in diseases such as hypertension.

21181 **Radioiodinated 5-iodothienyl-2-substituted long chain fatty acids for myocardial imaging.** Goodman, M.M.; Knapp, F.F. Jr.; Kirsch, G.; Owen, B.A. (Nuclear Medicine Group, Oak Ridge National Lab., Oak Ridge, TN). *Journal of Nuclear Medicine;* **25**: No. 5, 122(1984). (CONF-840619—). Contract W-7405-ENG-26.

From 31. annual meeting of the Society of Nuclear Medicine; Los Angeles, CA, USA (5 Jun 1984).

Thienyl-2-alkyl derivatives undergo facile iodination regiospecifically at the 5-position of the thiophene ring and are alternatives to iodophenyl agents. /sup 125/I-labeled 2-(17-oxoheptadecanoly)-5-iodothiophene (VIIIa) and /sup 125/I-labeled 2-(13-oxotridecanoyl)-5-iodothiophene (VIIIb) were prepared as model agents. The substrate was 2-(17-oxoheptadecanoyl)thiophene (VIa), in which the thiophene ring was attached to the terminal position of heptadecanoic acid. (VIa) was prepared by Friedel-Crafts condensation of 16-iodohexadecanoyl chloride, with thiophene followed by -I + CN/sup -/ → -CN; Wolff-Kishner reduction; -CN + OH/sup -/ → -COOH (VI). Regiospecific rho-[bis-(trifluoroacety 1)] thallation of (VIa), followed by treatment with KI gave 2-(17-oxoheptadecanoyl)-5-iodothiophene (VIIIa). Compound VIIIb was prepared in the same manner. Compounds Ia, b-VIIIa,b, were analyzed by TLC, IR, MS, NMR, and C&H. I-125-labeled (VIIIa) and (VIIIb) were prepared in the same manner. I-125 (VIIIb) showed high myocardial uptake in rats (4/group). Iodothienyl fatty acids may represent alternatives to iodophenyl substituted fatty acids for myocardial imaging.

21182 **Syntheses and radiobrominations of some trimethylsilylphenethylamines.** Wilbur, D.S. (Los Alamos National Lab., Los Alamos, NM 87545). *Journal of Nuclear Medicine;* **25**: No. 5, 124(1984). (CONF-840619—).

From 31. annual meeting of the Society of Nuclear Medicine; Los Angeles, CA, USA (5 Jun 1984).

Studies of the applications of arylsilane intermediates to radiobrominations have continued with the syntheses of four trimethylsilyl(TMS) substituted phenethylamines. Initial radiobromination studies have involved the nonprotected amines to determine if the ipso electrophilic substitution reactions would occur prior to reaction of the halogen with the amine. Indeed, radiobrominations of 1,2,&4 using carrier-added bromine-77 and stoichiometric amounts of N-chlorosuccinimide (NCS) gave the desired products in good yields. Radiobrominations of 3 under identical reaction conditions yielded a product which was consistent with compound 9 by chromatographic and spectroscopic analyses. When the oxidizing agent was used in excess of bromide ion, a significant amount of a more lipophlic radiobrominated compound was also observed by radio HPLC. The lipophilic compound was the major product when t-BuOCl was used as the oxidant, but was only a minor product when NCS was used. The syntheses of the phenethylamines, 1-8, was accomplished via standard methods (e.g. Knoevenagel Reaction), and is described.

21183 **C-11-labeled octadecylamine, a potential agent for positron tomographic pulmonary metabolism studies.** Washburn, L.C.; Wallace, R.T.; Byrd, B.L.; Sun, T.T.; Coffey, J.L.; Hubner, K.F. (Medical and Health Sciences Div., Oak Ridge Associated Universities (ORAU), Oak Ridge, TN). *Journal of Nuclear Medicine;* **25**: No. 5, 126(1984). (CONF-840619—). Contract AC05-76OR00033.

From 31. annual meeting of the Society of Nuclear Medicine; Los Angeles, CA, USA (5 Jun 1984).

C-11-Labeled straight-chain primary aliphatic amines are rapidly and selectively sequestered by lung endothelial cells, making these agents potentially useful for positron tomographic studies of the lung as a metabolic organ. However, because amines having straight chains containing 4 to 13 carbon atoms are rapidly catabolized in vivo with loss of radiolabel, quantitation of pulmonary concentration is difficult. The authors have studied the effect of structural changes on the uptake and retention of primary aliphatic amines in rat lung and found that the metabolic loss form the lung decreased with increasing length of the straight carbon chain. In fact, the lung concentration of octadecylamine, a straight-chain amine with 18 carbon atoms, was constant between 1 and 30 minutes after intravenous administration. This highly insoluble amine was solubilized using 3% aqueous human serum albumin. Unilateral, radiation-induced lung injury in the rat was used as a model to study the potential of C-11-labeled octadecylamine. Radiation-damaged (3000 and 5000 Rads) lungs had significantly lower 15-minute uptakes of the labeled amine than the corresponding nonirradiated lungs. However, at 8000 Rads the concentration in both lungs was greatly suppressed, indicating that the decrease in metabolism becomes systemic at high radiation doses. These results suggest that C-11-labeled octadecylamine is a potentially useful agent for quantitative evaluation of pulmonary metabolism by positron tomography.

21184 **Optimization and evaluation of the in vitro method for labeling RBC in whole blood with Tc-99m.** Srivastava, S.C.; Straub, R.; Som, P.; Yamamoto, K.; Atkins, H.L.; Oster, Z. (Brookhaven National Lab., Upton, NY). *Journal of Nuclear Medicine;* **25**: No. 5, 128(1984). (CONF-840619—).

From 31. annual meeting of the Society of Nuclear Medicine; Los Angeles, CA, USA (5 Jun 1984).

This study was undertaken to establish optimum conditions for the selective labeling of RBC in whole blood with Tc-99m, and to evaluate the in-vivo behavior of the labeled RBC. Effect on Tc-99m labeling of parameters such as the chemical form and the content of tin in the kits, uptake kinetics, the role of oxidants and chelating agents for the removal of extracellular tin, volume effects, etc., were investigated using Sn-117m or Sn-113 labeled kits. Out of the several ligands studies, citrate and glucoheptonate were found to be most effective for transporting tin into the cells. Stannous citrate kits containing 2, 15 and 50 μg tin were selected for further studies. The tin uptake into RBC was found to increase in proportion to the blood volume, tin content of kits and incubation times. The uptake was fastest within the first 10 min and then it increased very slowly up to 2 hr. The uptake of Tc-99m was dependent only on the extracellular tin (II); intracellular tin content was important only when carrier levels of Tc-99 were present. The final procedure was: (I) incubation of 1-4 ml blood with 50 μg tin (Sn/sup 2+/ citrate) kits for 5 min; (II) addition with mixing of 0.6 ml 0.1% NaOCl followed by 1.0 ml 4.4% disodium EDTA; and (III) addition of the desired amount of /sup 99m/TcO/sub 4//sup -/ and incubation for 15 min. Labeling yields were consistently >95%. Studies in dogs demonstrated that the in vivo survival of the label in blood was equal to or somewhat superior than that when using other labeling techniques. In a study in human volunteers (n=16) excellent images of the blood pool were obtained. At 45 min after injection, 97% activity remained intravascular and 94% of this was associated with the RBC.

21185 **Lung physiology and anatomy.** Susskind, H.; Rezak, I. (Brookhaven National Lab., Upton, NY). pp 1-27 of Pulmonary nuclear medicine: Techniques in diagnosis of lung disease. Atkins, H.L. New York, NY; Marcel Dekker Inc. (1984). Contract AC02-76CH00016.

This paper discusses the factors influencing respiration and presents the physiological principles that provide the basis for pulmonary function measurements and for the procedures used in pulmonary nuclear medicine. Respiration is defined as the consumption of O/sub 2/ and the production of CO/sub 2/ at the cellular level, and by extension in common usage the term refers to the entire process leading to gas exchange between the body and the environment. Gas exchange in man can be divided into three principal, but interdependent, functional components: (1) that concerned with the volume and and distribution of air flow within the lungs; (2) that concerned with the volume and distribution of blood flow through the pulmonary circulation; and (3) that concerned with the diffusion of O/sub 2/ and CO/sub 2/ across the air-blood barrier. The air-blood barrier in the terminal respiratory units is the site at which inspired fresh air (ventilation) is brought into contact with the film of blood flowing through the pulmonary capillaries (perfusion).

21186 **Pneumoconiosis.** Susskind, H.; Atkins, H.L. (Brookhaven National Lab., Upton, NY). pp 201-216 of Pulmonary nuclear medicine: Techniques in diagnosis of lung disease. Atkins, H.L. New York, NY; Marcel Dekker Inc. (1984).

Current research with modern techniques may help in improving the classification of pneumoconioses. Detection of early

changes and recognition of continuing activity of inflammatory processes are areas where radionuclide techniques are expected to be useful. Because of the nonspecificity of these methods, however, there must be correlations with other data. Above all, a careful occupational history is required. There is little or no information regarding the use of radionuclide techniques in pneumoconioses other than those discussed here. Because of many of these other disorders are of a restrictive nature the use of perfusion and ventilation studies will probably be of little assistance in detection or classification. /sup 67/Gallium citrate imaging may be helpful in estimating disease activity. A complicating factor in the exploration of the pneumoconioses is the prevalence of chronic lung diseases secondary to other causes which may occur superimposed on the pneumoconiosis.

21187 **Syntheses of [/sup 18/F] aryl fluorides by fluorination of aryltrimethylsilanes or arylpentafluorosilicates with [/sup 18/F]F/sub 2/ or [/sup 18/F]CH/sub 3/CO/sub 2/F.** Speranza, M.; Shiue, C.Y.; Wolf, A.P.; Wilbur, D.S. (Brookhaven National Lab., Upton, NY). *Journal of Nuclear Medicine;* **25**: No. 5, 126(1984). (CONF-840619—).

From 31. annual meeting of the Society of Nuclear Medicine; Los Angeles, CA, USA (5 Jun 1984).

F-18 Aryl fluorides are the important intermediates for the syntheses of F-18 labeled radiopharmaceuticals. F-18 Labeled aryl fluorides have been synthesized either from [/sup 18/F]F/sub 2/ or [/sup 18/F]fluoride. The authors report here the syntheses of [/sup 18/F]aryl fluorides by fluorination of aryltrimethylsilanes (1) or arylpentaflurorsilicates (2) with [/sup 18/F]F/sub 2/ or [/sup 18/F]CH/sub 3/CO/sub 2/F. Fluorination of compounds (1) with either [/sup 18/F]F/sub 2/ or [/sup 18/F]CH/sub 3/CO/sub 2/F give the corresponding aryl fluorides (3) and the aryltrimethylsilyl fluorides (4) in 2-10% yields depending on the reaction conditions. Compounds (2) and (3) can easily be separate by HPLC or GLC. Treatment of compounds (4) with HClO/sub 4/-MeOH (1:1) give the corresponding desilylated compounds (3underscore). Fluorination of compounds (2) with [/sup 18/F]CH/sub 3/CO/sub 2/F give the corresponding aryl fluorides (3) in 10-20% yield. The yields of compounds (3) and (4) depend on the reaction conditions. Lower temperature (-76°C in freon vs 25°C in CH/sub 3/CO/sub 2/H) favors the formation of aryl fluorides, [/sup 18/F]F/sub 2/ gives a better yield of aryl fluorides than with [/sup 18/F]CH/sub 3/CO/sub 2/F, and the electron-withdrawing groups are in favor of aryl fluoride formations. This method thus provides an alternative route to F-18 labeled radiopharmaceuticals such as p-/sup 18/F]fluorohippuric acid which is otherwise difficult to prepare, and other F-18 labeled neuroleptics.

## 5507 Microbiology

*REFER ALSO TO CITATION(S) 19973, 21144, 21145, 21147*

21188 **(SERI/STR—231-3089) Ultrastructural and flow cytometric analyses of lipid accumulation in microalgae.** Solomon, J.A.; Hand, R.E. Jr.; Mann, R.C. (Oak Ridge National Lab., TN (USA); Solar Energy Research Inst., Golden, CO (USA)). Dec 1986. Contract AC02-83CH10093. 55p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87001141.

Lipid accumulation in three species of microalgae was investigated with flow cytometry (FCM) and transmission electron microscopy (TEM). Previous studies using batch cultures of a algae have led to the assumption that lipid accumulation in microalgae is a gradual process requiring at least several days for completion. However, FCM reveals, through changes in the chlorophyll:lipid ratio, that the time span required for individual cells to change metabolic state is short. Simultaneous FCM measurements of chlorophyll and nile red (neutral lipid) fluorescence in individual cells of nitrogen-deficient Isochrysis populations revealed a bimodal population distribution as one stage in the lipid accumulation process. The fact that two discrete populations exist, with few cells in an intermediate stage, suggests rapid response to a liqid trigger. Interpretations of light and electron microscopic observations are consistent with this hypothesis. The time required for an entire population to achieve maximum lipid content is considerably longer than that required for a single cell, due to the variation in response time among cells. In this study high lipid cultures were sometimes obtained by using FCM to separate high lipid cells from the remainder of the population. FCM holds much promise for strain enhancement but considerable developmental work, directed at providing more consistent results, remains to be done. 8 refs., 35 figs.

## 5508 Morphology

*REFER ALSO TO CITATION(S) 21116*

## 5509 Pathology

21189 **(PNL-SA—14361) Canine lymphoma.** Weller, R.E. (Pacific Northwest Lab., Richland, WA (USA)). Oct 1986. Contract AC06-76RL01830. 14p. (CONF-8610251—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006403.

From Kal Kan symposium on veterinary oncology; Columbus, OH, USA (10 Oct 1986).

Canine lymphoma has served as the "workhorse" for the development of veterinary oncology and as an important animal model for human non-Hodgkins lymphomas. Significant advances have been achieved in understanding the biological behavior of the disease and in its treatment. Although it is unlikely that a cure for lymphoma will be achieved, owners should be encouraged to treat their pets, provided they understand that only prolonged remissions and survivals are likely to result. Cooperative studies, employing large numbers of dogs, are needed to optimize and refine the classification scheme to provide a system with diagnostic and prognostic correlates and derive maximum benefit from therapeutic regimens. Such studies need to be prospective in nature, with a solid statistical base incorporated into their design. Rather than being content with what we have accomplished to date in treatment of canine lymphoma, the opportunity exists for the veterinary profession to make further significant contributions to the understanding and treatment of lymphoma in the dog. 10 refs., 4 tabs.

21190 **(PNL-SA—14707) Paraneoplastic syndromes.** Weller, R.E. (Pacific Northwest Lab., Richland, WA (USA)). Oct 1986. Contract AC06-76RL01830. 20p. (CONF-8610251—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006401.

From Kal Kan symposium on veterinary oncology; Columbus, OH, USA (10 Oct 1986).

Paraneoplastic syndromes (PNS) comprise a diverse group of disorders that are associated with cancer but unrelated to the size, location, metastases, or physiologic activities of the mature tissue of origin. They are remote effects of tumors that may appear as signs, symptoms or syndromes which can mimic other disease conditions encountered in veterinary medicine. Various types of PNS, singly or in multiples, may be associated with either benign or malignant tumors and may involve almost every organ system, directly or indirectly. These disorders can precede the discovery of the tumor by weeks, months, or even years, and many are good diagnostic and prognostic indicators. The true incidence of PNS in animal cancer patients is unknown, although approximately 75% of all human cancer patients, at some time during the tumor-bearing part of their lives, suffer from one or more of these disorders. Recognition of PNS is valuable because the observed abnormalities may represent tumor cell markers and facilitate early diagnosis of the tumor, because they may allow assessment of premalignant states, because they may aid in the search for metastases, because they may help quantify and monitor response to therapy, and because they may provide insight into the study of malignant transformations and oncogene expression. Recognition of these syndromes is relevant to the diagnosis and treatment of many problems in veterinary cancer medicine. 22 refs., 2 tabs.

## 5510 Physiological Systems

*REFER ALSO TO CITATION(S) 21142, 21185*

21191 (INIS-mf—10578, pp 394) **Evidence for autocrine regulation by gonadotropin releasing hormone in breast cancer cell lines.** Eidne, K.; Harris, N.S.; Roeske, R.; Dutlow, C.; Wilcox, J.N.; Millar, R.P. 1986. NTIS (US Sales Only), PC A22/MF A01. File Number DE87780106. (CONF-8606256—).

From 1. joint congress of the South African Biochemical Society, South African Genetics Society and the South African Society for Microbiology; Johannesburg, South Africa (29 Jun 1986).

21192 **Effects of nutrition on age determination using eye lens weights.** Teska, W.R.; Pinder, J.E. III. (Furman Univ., Greenville, SC). *Growth;* 50: No. 3, 363-370(Aut 1986). Contract AC09-76SR00819.

Populations of hispid cotton rats (Sigmodon hispidus) were studied in 6 young loblolly pine (Pinus taeda) plantations in South Carolina, USA. Each plantation had 2, 1-ha, live-trapping grids; 1 to sample a Sigmodon population which continually received supplemental food, the other to sample a control population. After 15 months of live-trapping, the Sigmodon were killed and their eye lenses removed, dried and weighed. Birth dates were calculated for 425 Sigmodon which were first captured when young. Patterns of eye lens growth for food-supplemented and control animals were compared using the Richards' growth functions and were significantly different. For animals less than 165 days of age, the functions predicted greater eye lens weights for control animals than food-supplemented animals. The reverse was true for animals older than 165 days of age. Because of the influence of nutrition on eye lens growth patterns, the assumption that laboratory animals or known-age animals from one population can be used to estimate the ages of animals from another population is not always valid.

21193 **Information processing in biological systems.** Mintz, S.L.; Perlmutter, A. New York, NY; Plenum Press (1985). 164p. (CONF-830134—). Plenum Publishing Corp., New York, N.Y.

From Orbis scientiae conference; Miami, FL, USA (17 Jan 1983).

This volume presents frontier research in information processing related to a variety of biological systems, including small assemblies of neurons in the cortex and large-scale metabolic systems; the statistics, dynamics, and phase transitions of stochastic information processing; and the microscopic-macroscopic interface in biological information processing. Physical principles and proteinoid experiments are discussed regarding the emergence of life and information and cause. The final paper offers a design for a one-dimensional brain.

21194 **Information processing in the cortex: the role of small assemblies of neurons.** Shaw, G.L.; Pearson, J.C. (University of California, Irvine, CA). pp 1-30 of Information processing in biological systems. Mintz, S.L.; Perlmutter, A. New York, NY; Plenum Press (1985). (CONF-830134—).

From Orbis scientiae conference; Miami, FL, USA (17 Jan 1983).

This paper presents arguments given for the proposed major roles played in cortical function by small assemblies of as few as 30 neurons. Predictions include that the processing capabilities of the primary visual cortex are much greater than those discovered in the pioneering work of Hubel and Wiesel. Results from experiments recording response from cat primary visual cortex to time sequence of bar stimuli show dramatic phenomena.

21195 **Information and cause.** Rosen, R. (Dalhousie University Halifax, Nova Scotia). pp 31-54 of Information processing in biological systems. Miutz, S.L.; Perlmutter, A. New York, NY; Plenum Press (1985). (CONF-830134—).

From Orbis scientiae conference; Miami, FL, USA (17 Jan 1983).

The author discusses the study of biological systems which revolves around the basic task of characterizing how systems which are living are distinguished from all other systems. Theoretical physics is examined, and the author notes that in the pursuit of elucidating physical nature in general, the task of theoretical physics has evolved into a subtle and sophisticated endeavor which constitutes one of the supreme achievements of man as a species. The author addresses the unreasonable situation of biology's negligible role in this evolution, whether as cause or as effect.

21196 **Information flow and complexity in large-scale metabolic systems.** Kohn, M.; Bedrosian, S. (University of Pennsylvania Philadelphia, PA). pp 55-67 of Information processing in biological systems. Miutz, S.L.; Perlmutter, A. New York, NY; Plenum Press (1985). (CONF-830134—).

From Orbis scientiae conference; Miami, FL, USA (17 Jan 1983).

This paper presents a graph theoretical model of multienzyme networks. Formal operations on the graph permit identification of the important paths for information flow in the system and the enzymes which control the metabolic activity of the network. Simplification of the graph facilitates the calculation of a normalized complexity index. A real 12-enzyme system was only 5.6% as complex as a randomly connected enzymic system, suggesting that metabolic pathways have evolved into efficient feedback systems. The reason for this efficiency may be the tendency of enzymes to form function clusters; enzymes which bind the same metabolities tend to communicated much more strongly among themselves than with the rest of the network.

21197 **Physical principles and proteinoid experiments in the emergence of life.** Fox, S.W. (University of Miami Coral Gables, FL). pp 69-91 of Information processing in biological systems. Miutz, S.L.; Perlmutter, A. New York, NY; Plenum Press (1985). (CONF-830134—).

From Orbis scientiae conference; Miami, FL, USA (17 Jan 1983).

This paper presents evidence for nonrandom polymers. A special kind of evidence of self-ordering is that which indicates that the sequences of amino acids is extremely nonrandom comparable to that observed through the modern coding mechanisms. The identities of peptides expected on the basis of the random hypothesis vs. those found are listed. These show that the actual result was highly nonrandom. The significance of selfordering is discussed, and anabolic and catabolic thermal proteins are examined. The physical principles quickly reviewed in this paper stem from a self-sequencing of amino acids.

21198 **Microscopic-macroscopic interface in biological information processing.** Conrad, M. (Wayne State University, Detroit, MI). pp 93-130 of Information processing in biological systems. Miutz, S.L.; Perlmutter, A. New York, NY; Plenum Press (1985). (CONF-830134—).

From Orbis scientiae conference; Miami, FL, USA (17 Jan 1983).

This paper examines recent experimental work that suggests that chemical messengers associated with the neuron membrane serve as a link between macroscopic and microscopic information processes in the brain. Arguments based on the physical limits of computing, on computational parallelism, and on evolution theory, suggest that microphysical computing processes enormously enhance the brain's computing power. A number of models are briefly sketched which illustrate how molecular switching processes could be recruited for useful biological functions. The flow of information between microscopic and macroscopic forms is suggestive of processes which occur in a measuring apparatus, and the implications of this analogy are considered.

21199 **Stochastic information processing in biological systems II - statistics, dynamics, and phase transitions.** Hastings, H.M. (Hofstra University Hempstead, NY). pp 131-144 of Information processing in biological systems. Miutz, S.L.; Perlmutter, A. New York, NY; Plenum Press (1985). (CONF-830134—).

From Orbis scientiae conference; Miami, FL, USA (17 Jan 1983).

The authors discuss the use of probabilistic automata and networks of probabilistic automata as a framework for modelling biological information processing and explore several consequences.

The Ising model is used and recurrence in Brownian motion to argue that the brain uses its twodimensional surface for primary data access. The paper also considers biological attacks on polynomial-time, and nondeterministic polynomialtime problems.

21200 **Design for a one-dimensional brain.** Rossler, O.E. (University of Tubingen). pp 145-153 of Information processing in biological systems. Miatz, S.L.; Perlmutter, A. New York, NY; Plenum Press (1985). (CONF-830134—).

From Orbis scientiae conference; Miami, FL, USA (17 Jan 1983).

The author wonders if it is possible to put consciousness into a home computer. He feels that the only way one may have any chance to accomplish this is by reducing the dimensionality of the class of problems that the brain to be designed must solve. This, he says, can indeed be done within the context of a certain abstract theory. This theory is outlined, and a way of how to design the simplest system of the most complicated subclass is indicated.

### 5520 Public Health

*REFER ALSO TO CITATION(S) 21069, 21093*

21201 **(PB—87-133674/XAB) NIOSH (National Institute for Occupational Safety and Health) research and demonstration grants. Annual report, Fiscal Year 1985.** (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA)). Sep 1986. 308p. (DHHS/PUB/NIOSH—86-123). NTIS, PC A14/MF A01.

The National Institute for Occupational Safety and Health (NIOSH) plans, directs, and coordinates a national program of research, training, and related activities to prevent occupational diseases and injuries among workers in the United States. Under the provisions of the Occupational Safety and Health Act of 1970 and the Federal Mine Safety and Health Amendments Act of 1977, research investigations constitute a principal responsibility of NIOSH. In turn, the support of outstanding extramural research is a major component of the research program. The report is published by NIOSH to provide a readily available source of information on the status and scope of the Institute's research grants program of NIOSH as means of stimulating the development of proposals for research of high quality on significant occupational safety and health problems. The interest of scientists is invited in the biomedical sciences, engineering, and related disciplines. Descriptions of all active grants during fiscal year 1985 (October 1, 1984, to September 30, 1985) are included, along with the publications resulting from the research.

### 5530 Agriculture And Food Technology

*REFER ALSO TO CITATION(S) 21153*

## 56 BIOMEDICAL SCIENCES, APPLIED STUDIES

### 5601 Radiation Effects

*REFER ALSO TO CITATION(S) 21159*

21202 **(CONF-870405—12) Sensitivity/uncertainty analysis for the Nagasaki dosimetry reevaluation effort.** Lillie, R.A.; Broadhead, B.L.; Pace, J.V. III; Cacuci, D.G. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004068.

From Radiation protection and shielding conference; Knoxville, TN, USA (22 Apr 1987).

Uncertainties have been calculated for the Nagasaki free-in-air (FIA) tissue kerma obtained from two-dimensional air-over-ground (A/G) transport calculations. The uncertainties due to modeling parameter and basic nuclear transport data uncertainties were calculated for ground ranges of 700, 1000, and 1500 m. Uncertainties of approximately 20% were obtained for the prompt neutron and secondary gamma kerma and 30% for the prompt gamma kerma. In general, the uncertainties are dominated by the modeling parameter uncertainties, particularly those associated with the weapon yield and radiation sources. 9 refs., 3 tabs.

21203 **(IRD-CNEN-NT—007/86) Risk assessment of lung cancer for Brazilian uranium mining workers.** (Instituto de Radioprotecao e Dosimetria, Rio de Janeiro (Brazil)). 1986. 14p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700963.

The fatality risks of lung cancer is estimated for several categories of miners working in the Brazilian uranium mine Osamu Utsumi in Pocos de Caldas, during the period of 03/76 to 07/78. A total of 198 miners were classified conforming the type of work performed and it was considered the lung dose equivalent received due only to the inhalation of the short lived airborne Radon-222 daughters. The average lung dose equivalent values were evaluated from the individual accumulated alpha exposure. These were expressed in unit of WLM derived from the periods of occupancy and working level data obtained by daily air monitoring using the Harley method. (M.A.C.).

21204 **(IRD-CNEN-NT—008/86) Radiological protection in X-ray diagnosis: How to minimize the patient exposure in X-ray diagnosis.** (Instituto de Radioprotecao e Dosimetria, Rio de Janeiro (Brazil)). 1986. 30p. (In Portuguese). NTIS (US Sales Only), PC A03/MF A01. File Number DE87700964.

The principles involved in the radiation protection and the radiographic process are discussed. An adequate systematic work is presented, to achieve the main goal of the radiation protection that is, to irradiate the patient and the staff with lowest possible exposure. (M.A.C.).

21205 **(UCRL—95789) Perspectives on radiation dose estimates for A-bomb survivors.** Loewe, W.E. (Lawrence Livermore National Lab., CA (USA)). Dec 1986. Contract W-7405-ENG-48. 10p. (CONF-870405—13). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003465.

From Radiation protection and shielding conference; Knoxville, TN, USA (22 Apr 1987).

Four decades after the actual events, quantitative characterization of the radiation fields at Hiroshima and Nagasaki continues to be sought, with high accuracy a goal justified by the unique contribution to radiation protection standards that is represented by the medical records of exposed survivors. The most recent effort is distinguished by its reliance on computer modeling and concomitant detail, and by its decentralized direction, both internationally and internally to the US and Japan, with resultant ongoing peer review and wide scope of inquiry. A new system for individual dose estimation has been agreed upon, and its scientific basis has been elaborated in the literature as well as in a comprehensive treatise to be published in the Spring of 1987. In perspective, this new system appears to be an unusually successful achievement that offers the expectation of reliable estimates with the desired accuracy. Some aspects leading to this expectation, along with a caveat, are discussed here. 4 refs., 8 figs., 3 tabs.

21206 **Effects of heavy ions on rabbit tissues: Induction of DNA strand breaks in retinal photoreceptor cells by high doses of radiation.** Lett, J.T.; Keng, P.C.; Bergtold, D.S.; Howard, J. (Colorado State Univ., Fort Collins, USA. Dept. of Radiology and Radiation Biology; Lawrence Berkeley Lab., CA, USA). *Radiation and Environmental Biophysics;* **26**: No. 1, 23-36(Mar 1987).

Excised retinas from New Zealand white (NZW) rabbits were irradiated at 0/sup 0/C with 9-260 Gy (depending on the type of radiation) of 300 kVp X-rays, or the first 5 cm (range: proportional to 14 cm in water) of 365 MeV/u Ne ions or 530 MeV/u Ar ions (LET/sub ∞/'S: proportional to 1,35+-3 and 90+-5 keV/μm, respectively). Other positions (LET/sub ∞/'S) in the Ne-ion beam (Bragg curve) were employed in more limited experiments. The retinas were frozen and stored in liquid nitrogen until analysis. Total strand breakage in the DNA of retinal photoreceptor (sensory) cells was determined from sedimentation profiles obtained by

velocity sedimentation through reoriented alkaline sucrose gradients under conditions free from anomalies related to rotor speed. For the radiation doses employed: The reciprocal of the number average molecular weight, M/sub n/, was related linearly to dose for each radiation quality and extrapolation to zero dose in each case gave positive intercepts for which the mean unirradiated molecular weight, M/sub 0/, was 6.1+-1.0 . 10/sup 8/ daltons; the efficiencies of total strand breakage for the different radiations were 50+-3, 110+-2 and 240+-6 eV/strand break, respectively. For the heavy ions, accurate analogous calculations for other positions in the Bragg curves were precluded by beam degeneration due to fragmentation of the primary particles, etc. Overall, the experimental results support the concept that ionizing radiations damage cellular DNA by two general processes. One process causes localized damage, which under our experimental conditions is revealed as strand breaks and/or alkali-labile bonds in regions between molecules of size circa 10/sup 9/ daltons (subunits); the other causes essentially random damage. Base damage caused by either process would not have been delineated in our experiments.

21207 **Genetic injury in hybrid male mice exposed to low doses of $^{60}$Co γ-rays or fission neutrons. 2. Dominant lethal mutation response to long-term weekly exposures.** Grahn, D.; Carnes, B.A.; Farrington, B.H. (Argonne National Lab., IL). *Mutation Research;* **162**: No. 1, 81-89(Aug 1986).

Male B6CF$_1$ mice were exposed to once-weekly doses of either fission neutrons or $^{60}$Co γ-rays for periods up to one year and mated periodically to screen for the induction of dominant lethal mutations. Two independent experiments were performed, each involving a control and three dose levels of both neutrons and γ-rays. Data on both pre- and post-implantation fetal deaths were obtained. Direct comparisons of these data with data from males exposed to single doses confirm that weekly neutron irradiation is significantly more effective than single doses for the induction of postimplant fetal losses, whereas single doses of γ-rays are more effective than the same dose divided into weekly fractions. Neutron-induced augmentation appears limited in these data to lethal mutations induced in meiotic and postmeiotic cell stages. Rates of preimplant loss, although significant, are not a sensitive measure of genetic injury at the low doses used here. They are extremely sensitive to litter size and best estimated in litters of seven or more implants along with appropriate statistical control of concurrent variation in the number of corpora lutea. 29 references, 5 tables.

21208 **Lack of UV-induced respiration shutoff in a recF strain of Escherichia coli: temperature conditional suppression at 30°C by the sfrA mutation.** Swenson, P.A.; Norton, I.L. (Oak Ridge National Lab., TN). *Mutation Research;* **160**: No. 3, 171-178(May 1986).

The authors report that respiration does not shutoff in a recF strain of Escherichia coli at 37 and 30°C. An srfA mutation suppresses this lack of respiration shutoff effect in a recF srfA mutant at 30°C but not at 37°C; no suppression by this mutation occurs at either temperature in a recF recBC sbcB strain. An srfA strain also does not shut off its respiration at 37°C and shows a temperature conditional UV-induced respiration shutoff response at 30°C. The srfA mutation is thought to cause an altered RecA protein to be produced and the authors suggest that at 37°C this altered protein is temperature sensitive. The authors conclude that the recF gene product is required for UV-induced respiration shutoff and that the RecA protein plays a special role in the induction process. 32 references, 5 figures, 1 table.

21209 **Somatic mutation response of Tradescantia stamen hairs to combined chemical and radiation exposures.** Bond, V.P.; Schairer, L.A.; Varma, M.N. (Biol. Dept., S & EP Div., BNL, Upton, NY 11973). pp 117 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

Combined effects of mutagens have been reported to exceed the sum of their individual responses. Such a synergism between radiation and chemicals at low levels would have a direct bearing on assessment of the genetic hazard of exposure to combined environmental mutagens. The high sensitivity of the flower color locus in Tradescantia clone 4430 to both radiation and chemical mutagens made it the assay of choice to study the combined effects of gamma rays with 1,2-dibromoethane (DBE) or ethyl methanesulfonate (EMS). Exposures to gaseous DBE were made by passing mutagen laden air over floral cuttings in gas-tight chambers. The treatments included DBE and gamma rays individually, DBE & gamma rays and a control. Low and high doses (7 ppm, 5 rad and 35 ppm, 52 rad respectively) were used to describe effects in single- and multi-hit kinetic regions of the response curve. In this experiment both low and high dose responses were less than additive. EMS was used in the liquid phase by immersing inflorescences in 10/sup -2/ M solutions for 4 hrs, following immediately by acute gamma irradiation with 2 to 82 rad. Combined treatments of EMS and 20 to 40 rad gave greater than additive results while below 10 rad the response was ≦ additive. These data indicate that a synergistic response between ambient levels of radiation and chemical mutagens is highly improbable.

21210 **A physiological basis for beneficial (hormetic) effects of whole-body ionizing radiation exposure.** Totter, J.R. (Oak Ridge Associated Universities, Oak Ridge, TN 37830). pp 111 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

Beneficial (hormetic) effects of ionizing radiation have been largely ignored in developing radiobiological theory, chiefly because a suitable explanatory hypothesis is lacking. Examination of the relevant literature has revealed that food restriction effects in animals resemble those of low-level low LET whole-body ionizing radiation exposure (without food restriction) in two major respects: 1) increased longevity, and 2) a change in the variance of longevity. These physiological changes can be interpreted as resulting from alteration of the "steady state" flux of oxygen radicals which affect the endocrine balance. Oxyradical-producing low-level ionizing radiation exposure (whole body) is interpreted by the body as excess food intake, thus lowering the appetite and reducing caloric intake which, in turn, increases longevity. The greater variance in longevity that accompanies increases in the mean age at death with food restriction alters the ratio of long-lived to short-lived descendants and hastens the population's adaptation to semi-permanently diminished rates of food supply. Less variance and earlier mean ages at death result from an increased rate of food supply. Whole body ionizing radiation exposure results in a mixed response because it reduced caloric intake while signaling that an increase has occurred.

21211 **Influence of hypertonic treatment on chromatin structure, DNA repair and recovery from radiation-induced potentially lethal damage (PLD).** VanAnkeren, S.C.; Wheeler, K.T. (Thomas Jefferson Univ. Hospital, Philadelphia, PA). pp 119 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

The relationship between the repair of radiation-induced DNA damage and recovery from radiation-induced PLD was investigated in 9L cells. Fed plateau phase cells were γ-irradiated with 1500 rad and immediately treated with 37°C isotonic (0.15 M NaCl) or hypertonic (0.50 M NaCl) HBSS. After 20 min the HBSS was replaced with 37°C conditioned medium for the remainder of the repair time. DNA damage and repair were assayed using alkaline elution and recovery from PLD was assayed by colony formation. Hypertonic treatment of unirradiated cells produced neither DNA damage nor cell kill but did alter the kinetics of chromatin digestion by M. nuclease and Dnase I. Post-irradiation hypertonic treatment inhibited both DNA repair and PLD recovery relative to post-irradiation isotonic treatment. However, by 2 hr after irradiation, the amount of DNA damage remaining was equivalent in both the hypertonically and isotonically treated cells while cell survival remained substantially lower in the hypertonically treated cells. These results suggest that time is an important factor in determining

cell survival and that the level of residual unrepaired DNA damage is not always causally related to recovery from radiation-induced PLD.

21212 **CFU-S survival and acute radiation lethality in mice irradiated with heavy charged particles (HCP).** Ainsworth, E.J.; Mahlmann, L.J.; Prioleau, J.C.; Howard, J. (Lawrence Berkeley Lab., Berkeley, CA 94720). pp 105 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

The authors described previously RBE-LET relationships for CFU-S killing using HCP beams spread to 4 or 10 cm with spiral ridge filters. Studies have been completed with doses in the plateau portion of the Bragg curve where particle fragmentation and the range of dose-averaged LETs are low compared with spread Bragg peaks. Estimates of RBE at 10% survival are 1.5 (/ sup 20/Ne), 1.8 (/sup 28/Si), 1.7 (/sup 40/Ar), 1.5 (/sup 40/Ar), and 1.3 (/sup 56/Fe) respectively, compared with /sup 60/Co $\gamma$ radiation. Based on LET estimates 25, 50, 100, 140, and 190 keV/$\mu$m, respectively, for the HCP specified, the authors conclude the RBE peak occurs in the range of 50-100 keV/$\mu$m. A similar conclusion was reached from CFU-S survival data collected previously with spread Bragg curves. In conjunction with potential future radiotherapeutic uses of 670 MeV/n /sup 28/Si ions, CFU-S killing was determined in the plateau and in the distal 4 cm of a Bragg curve spread to 12 cm. RBE in the plateau was significantly higher, 1.8, than in the distal peak, 1.2, where LETs estimated at the two positions are 50 and 160 keV/$\mu$m, respectively. Data collected on lethality within 30 days after total body exposure is also presented.

21213 **Prostaglandin induced radioprotection in murine bone marrow stem cells and CHO cells.** Hanson, W.R.; Ainsworth, E.J. (RPSLMC, Chicago, IL 60302). pp 106 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

High concentrations of prostaglandins (PG) have been associated with a variety of diseases. However, a previous study reported an intestinal cytoprotective effect of PG when given before ulcerogenic treatment of indomethacin or absolute alcohol. Subsequently, another study showed that 16-16dm PGE/sub 2/ protected intestinal stem cells in mice if given before radiation. The shoulder and D/sub o/ of the survival curve was shifted to higher values in PG treated animals. To test whether 16-16dm PGE/sub 2/ induced radioprotection was unique to the intestine, survival of CFU-S was assayed in irradiated mice and compared to mice given the PG 1 hr before /sup 60/Co $\gamma$ irradiation. To assess In Vitro PG induced radioprotection, cell survival was measured in CHO cell cultures irradiated only or after a 2 hr incubation with the PG. The 16-16dm PGE/sub 2/ protected CFU-S similarly to intestinal stem cells. The shoulder was significantly increased from 1.0 to 1.4 and the D/sub o/ was increased from 0.92 to 1.14 Gy. However there was no PG induced radioprotection in CHO cells confirming results using V-79 cells. These results show that PG induced radioprotection is not unique to intestinal stem cells, however, a difference apparently exists comparing radioprotection In Vivo and In Vitro.

21214 **Effect of sequential exposures to radiation of different quality on neoplastic cell transformation.** Yang, T.C.; Howard, J.; Tobias, C.A. (Biology and Medicine Div., Univ. of California, Lawrence Berkeley Lab., Berkeley, CA 94720). pp 124 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—). Contract AC03-76SF00098.

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

Using cultured mouse embryo cells (C3H10t1/2, clone 8) as the model system, the authors have investigated the interaction between U.V. and x-rays on neoplastic cell transformation and found a synergistic effect when cells were irradiated first with U.V. followed by x-rays. Recently, they initiated studies on the effect of sequential exposures to low- and high-LET ionizing radiation on cell killing and neoplastic cell transformation. Experimental results suggest that lesions induced by x-rays and heavy particles can interact for both cell killing and neoplastic cell transformation. When cells were irradiated first with x-rays and followed immediately by silicon ions (320 MeV/n; LET = 86 keV/$\mu$m), for example, the shoulder of the survival curve decreased. A change in survival curve shoulder was also found for cells irradiated with silicon ions and followed by x-rays. On a semilog plot, the transformation frequency per survivor for cells exposed to mixed radiation is parallel to and consistently higher than that for cells irradiated with x-rays or silicon ions only, suggesting that x-rays and heavy ions do not act independently.

21215 **In vitro cellular transformation induced by the hypoxic cell radiosensitizers Ro-03-8799 and RSU-1069.** Hei, T.K.; Hall, E.J. (Columbia Univ., New York, NY 10032). pp 124 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

Two experimental hypoxic cell radiosensitizers, Ro-03-8799 and RSU-1069 were investigated for their ability to induce in vitro oncogenic transformation using the C/sub 3/H 10T1/2 cell system. Logarithmic phase cultures of C/sub 3/H 10T1/2 cells were plated at a density that allowed for approximately 400 to 500 cells per dish to survive the treatment with drug or radiation or the combination of both. All drug treatments were performed under aerated condition; for times ranging from 1 to 3 days. Following treatment, each dish was washed twice with phosphate-buffered saline and then replenished with fresh medium. The cultures were maintained for a total of six weeks after which time they were fixed, stained and type II and III foci were scored as transformants. Ro-03-8799 and particularly RSU-1069 were found to be significantly more cytotoxic than equivalent dosages of Misonidazole or SR-2508. In addition, they also induced significant transformation frequencies. RSU-1069 at a concentration of 0.03 mM; and Ro-03-8799 at a concentration of 1 mM produced a transformation incidence roughly comparable to 2 Gy of $\gamma$-rays. When combined with $\gamma$-rays, both sensitizers produced transformation frequencies larger than with either drug or radiation alone, and this potentiation appeared to be additive rather than synergistic.

21216 **Promoting effect of bile acids on neoplastic transformation of x-irradiated 10T1/2 cells.** Han, A.; Hill, C.K. (Univ. Southern California School of Medicine, Los Angeles, CA 90015). pp 124 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

Experimental studies have raised a concern about a role of bile acids in colo-rectal carcinogenesis. Studies in vivo suggest that bile acids may act as tumor promoters. Using 10T1/2 mouse cells as a model system, the authors explored the effects of cholic and cheno-deoxycholic acid on x-ray-induced neoplastic transformation in these cells. Addition of either cheno-deoxycholic acid or cholic acid to 10T1/2 cells, 24 hours after exposure to x-rays (50kv) increases significantly the frequencies of transformation. The compounds were present in the medium throughout the entire postirradiation refeeding period. At the concentrations used (0.5$\mu$g/ml), neither acid was cytotoxic and did not have any effect on cell survival. The enhancement of radiation-induced transformation seems to be greater in the presence of cholic acid, as compared to the effect of cheno-deoxycholic acid. Increase in transformation was relatively greater after low compared to high doses of radiation. The effect of bile acids on transformation of 10T1/2 cells is similar to that of a known tumor promoter TPA. The authors' observations support the conclusion that promotional effect of bile acids is not because of their specific effect on colonic epithelium, but rather due to their general properties as tumor promoters.

21217 **Qualitative and quantitative differences in neoplastic transformation induced by low doses of /sup 60/CO γ-rays and fission spectrum neutrons.** Hill, C.K.; Han, A.; Elkind, M.M. (Mammalian Cell Biology Group, Argonne National Lab., Argonne, IL 60439). pp 125 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—). Contract W-31-109-ENG-38.

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

The authors have examined the effect of fission-spectrum neutrons from the JANUS reactor at Argonne National Laboratory delivered either as acute (10-38 rads/min), protracted (0.086 or 0.43 rad/min), or multifractionated irradiation, on the incidence of neoplastic transformation in the C3H 10T1/2 cell line. In the low-dose region (up to about 80 rads), the transformation frequency was significantly enhanced by protraction of the radiation dose, but cell survival was not changed. When the authors compared the fission neutron data to data from similar dose protraction experiments carried out using /sup 60/Co γ-rays (0.1 to 100 rad/min), they found a reverse dose rate effect, with neoplastic transformation increasing as the dose rate was decreased below 2.5 rad/min. At dose rates below 0.4 rad/min, the authors found a possible saturation of transformation. When protected dose data are compared, the RBE is as high as 50 for the neoplastic transformation end point in the low-dose region.

21218 **Early and late events in radiation-induced neoplastic transformation in vitro.** Elkind, M.M.; Han, A.; Hill, C.K. (Mammalian Cell Biol. Group, ANL, Argonne, IL 60439). pp 125 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

Irradiation of C3H 10T1/2 cells with protracted doses of / sup 60/Co γ-rays or fission-spectrum neutrons leads to opposite changes in the low-dose parts of the transformation induction curves. Transformation is decreased by a reduced dose rate (D′) of γ-rays but it is increased by a reduced D′ of neutrons. These results indicate that radiation-induced "early events" are influenced by both the quality and the timing of the radiation. However, after a given radiation exposure, the addition (1 day later) of a promoting agent (i.e., TPA, 12-0-tetradecanoylphorbol-13-acetate) enhances transformation in all cases but the enhancement depends on the radiation and the delivery time. At low and high D′s, γ-rays and TPA lead to initial slopes steeper by equal factors but not for neutrons + TPA. Neutrons + TPA increase transformation but low D′ is now not more effective than high D′. Although the modulation by TPA demonstrates the role of a "late event" in transformation, its expression depends upon the degree of effect of the early event.

21219 **Effects of the radioprotectors WR-2721 and WR-1065 on cell killing, mutagenesis, and transformation.** Grdina, D.; Hill, C.; Peraino, C. (Argonne National Lab., Div. of Biological and Medical Research, Argonne, IL 60439). pp 125 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—). Contract W-31-109-ENG-38.

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

WR-2721 (S-2-[3-aminopropylamino] ethylphosphorothioic acid) significantly reduced the number of radiation-induced tumors in C/sub 3/H mice. The authors therefore tested WR-2721 and a related compound, WR-1065 (N-[2-mercaptoethyl]-1,3 diaminopropane), for toxicity, mutagenicity, and transformation in several systems. In V79 Chinese hamster cells, 100% survival occurred after 3-hr exposures to either 1 mM or 10 mM levels of WR-2721; similar exposures to WR-1065 yielded about 60% (1 mM) and 80% (10 mM) survival levels. Using resistance to 6-thioguanine in the V79 cells as the index of mutagenicity, they found the mutation frequency (uncorrected for background) to range from 11 x 10/sup -6/ to 44 x 10/sup -6//surviving cell. In vivo transformation studies in newborn Sprague Dawley rats revealed an unexpected toxicity; all animals given doses of 200 and 400 mg/kg of WR-2721 died within 24 hr. No host toxicity was observed at doses of 50 or 100 mg/kg. The role of WR-2721, administered alone or in combination with radiation and/or diethylnitrosamine (DEN), in liver foci and tumor formation is discussed.

21220 **Very heavy ions: Chromosomal aberrations and inactivation of mammalian cells.** Kraft, G.; Weyrather, W.K.; Muller, W.; Miltenburger, H.; Schubert, M.; Blakely, E.; Roots, R.; Tobias, C. (Gesellschaft fur Schwerionenforschung and Technische Hochschule, Darmstadt). pp 135 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

The inactivation of V79 Chinese hamster cells and the induction of chromosomal aberrations has been measured for heavy ions from alpha particles to uranium in an LET range between 10 and 15,000 keV/μm. As reported previously, the inactivation measurements indicate that at LET values >1,000 keV/μm the structure of the particle track is more important for cell killing than the LET value. In the chromosome studies the induction of aberrations as a function of dose and time interval after the exposure has been measured. At low doses the authors observe a steep increase in the aberration induction as a function of dose, which levels off for higher doses. Similar to the inactivation measurements the number of cells having chromosomal damage is more correlated to track structure than to LET alone. The effectiveness of aberration production in a single cell increases, however, with increasing atomic number of the projectile.

21221 **LET dependence of survival curve shape in chlamydomonas.** Jacobson, B.S.; Braby, L.A.; Roesch, W.C. (Central Michigan Univ., Mt. Pleasant, MI 48859). pp 136 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

Chlamydomonas reinhardi, a haploid eukaryotic alga, was grown synchronously. A tandem Van de Graaff accelerator was used to produce protons and deuterons with LET's of 13 to 26 MeV-cm/sup 2//g and /sup 3/He and /sup 4/He nuclei at 71 to 87 MeV-cm/sup 2//g. Low-LET electrons were supplied by a 1.5 MeV electron Van de Graaff machine. The survival curves were fitted to the linear quadratic formula: $S = \exp(-\alpha D + \beta D/\text{sup } 2/)$. In contrast to the response of mammalian cells, the first-power coefficient, $\alpha$, remained at zero, or slightly less than zero, for all LET values up to 26 MeV-cm/sup 2//g. At the higher values it became positive; however, even at the highest stopping power, the curve had an obvious shoulder. The second-power coefficient, $\beta$, increased gradually with increasing LET up to 71 MeV-cm/sup 2// g, and rapidly between 71 and 87 MeV-cm/sup 2//g. This suggests that intra-track interactions may be largely responsible for "sublesions".

21222 **Lung cancer risk at low doses of alpha particles.** Hofmann, W.; Chunxiang, Z.; Katz, R. (Univ. of Salzburg). pp 103 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

An earlier analysis of carcinogenic data from inhaled radon daughters led to the suggestion that carcinogenesis is a quadratic or cubic function of dose, when tract structure estimates of cell killing is factored into the analysis. This conclusion is supported by data from high background areas in China and from a radon spa in Austria. In China, where the average concentration of radon indoors was 0.93 rhoCi/1 and of thoron was 4.5 rhoCi/1, with a sample of over 500,000 person years, whose mean annual dose in segmential bronchioles was 6.2 rem, there were a total of 12 cancer deaths in an 11 year period. In a control area where the dose level was about 1/3 the high background area there were 26 deaths. Here the total

number of deaths is lower by factor 6 than the BEIR based estimate of excess deaths. Data from Badgastein at dose levels comparable to the high background Chinese data show an annual lung cancer production not statistically different from the entire province of Salzburg.

21223 **Radiosensitivity of stimulated lymphoid organs to Cf-252, Cs-137, and Co-60 radiations.** Maruyama, Y.; Feola, J.M.; Magura, C. (Univ. of Kentucky, Radiation Therapy Oncology Center, Lexington, KY 40536). pp 104 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

Cf-252 is a novel fast neutron emitting radioisotope which has demonstrated 5 year cure of advanced human cancers and produces rapid clearance of bulky tumor masses. Tissue sensitivity is being assessed in animal systems to assess acute and chronic effects in comparison with gamma ray ionizing radiations. Reference radiations used were acute Co-60 and low dose rate (LDR) Cs-137. Corynebacterium parvum (CP) was used to produce a proliferating state in spleen. Dose response survival curves for maximum thymus weight loss showed a 2 component survival curve (sensitive and resistant) with a RBE/sub (n)/ = 2.0 for the sensitive component. By 50% weight loss by log dose method RBE/sub (n)/ was 4.0. Similar studies of spleen weight loss used resting spleen and CP-induced proliferating spleen. Resting spleen demonstrated 2 component survival curves which became single slope curves for the CP-stimulated spleens. Cf-252 radiations always had steeper dose-response curves and a higher RBE whether in resting or stimulated spleens. LDR Cs-137 always showed a dose rate effect indicating tissue recovery. Thymus shrinkage was produced by CP and, therefore was not studied. The spleen RBE by weight change assay was assessed for resting or proliferating tissue.

21224 **Recovery of mouse jejunal crypt cells as a function of time after radiation.** Risius, P.P.; Alpen, E.L.; Harrison, L.D.; DeGuzman, R.J. (Biology and Medicine Div., Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). pp 107 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—). Contract AC03-76SF00098.

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

The authors have measured the fractional recovery of mouse crypt cells as a function of time between two doses of radiation. Mice were given an initial conditioning dose (D/sub 200/) of the "test" radiation and at various times between 12 hours and 5 days later, were re-irradiated with graded doses of X rays. The unrecovered fraction of x-ray equivalent damage was estimated by taking the difference between the D/sub 200/ for the "test" radiation plus x-ray curve, and the D/sub 200/ for the x-ray only curve. The authors have used x rays, helium and neon ions for the "test" radiations. The x ray plus x ray and the helium (plateau and mid-peak) plus x ray recovery patterns are similar: 65% of the "test" radiation is not recovered by 12 hours, and 40% by 48 hours. By 72 hours the recovery is complete, and the "test" radiation plus X-ray survival curve is equivalent to the survival curve for animals that had not received a conditioning dose.

21225 **Survival of tumor bearing mice by sequencing of low dose rate (LDR) neutron and photon radiation.** Onomura, C.I.; Feola, J.M.; Maruyama, Y. (Radiation Medicine, Univ. of Kentucky Medical Center, Lexington, KY). pp 132 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—).

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

Cf-252 neutron radiation (NT) has been shown to be effective therapy for bulky, hypoxic human tumor and to produce consistent rapid clearance and 5 year cures. NT has been found to be more or less effective depending upon the schedule in which it is used and upon mixing with photon radiation. In an effort to study this scheduling and photon effect, LSA tumor was irradiated in vivo in a hypoxic, advanced state, in different schedules in combination of NT with Co-60 photons. The LSA lymphoma of C57BL/ym mice represents an accurate system to assess dose-response of tumor cells in vivo. Mean survival time was used as endpoint. A high RBE for LDR Cf-252 NT was observed with a RBE(n) of — 5.0. The effect was not greatly sensitive to sequence in which photons were used. Comparison studies were also tested relative to LDR Cs-137 photon radiation. The results support the high efficacy of LDR NT for destruction of hypoxic tumor in vivo.

21226 **A model for calculating reactions in irradiated aqueous solutions containing DNA.** Wright, H.A.; Magee, J.L.; Turner, J.E.; Hamm, R.N.; Chatterjee, A.; Ritchie, R.H. (Health and Safety Research Div., Oak Ridge National Lab., Oak Ridge, TN 37831). pp 29 of Abstracts of papers for the thirty-second annual meeting of the Radiation Research Society. Philadelphia, PA; Radiation Research Society (1984). (CONF-8403123—). Contract W-7405-ENG-26.

From 32. annual scientific meeting of Radiation Research Society; Orlando, FL, USA (1 Mar 1984).

The authors have previously described a Monte Carlo computer code for calculating the production and subsequent reactions of chemical species produced in irradiated liquid water. They have initiated a program to extend this work to include interactions with biological macromolecules in solution. Each individual reactive species is followed in time until it is scavenged, reacts with another species, or reacts at a specific site on the molecule. Reactions of OH radicals with the sugar moiety on the macromolecule are considered as a basis for single and double strand breakage in DNA. The model separates the direct and indirect effects of radiation. The first results in this study where the authors have considered a crude model to simulate reactions with DNA are presented.

21227 **Soft x-rays as a tool to investigate radiation-sensitive sites in mammalian cells.** Brenner, D.J.; Zaider, M. (Los Alamos National Lab., MP-3, MS H809, Los Alamos, NM 87545). pp 172-179 of Science with soft x-rays. Volume 447. Himpsel, F.J.; Klaffky, R.W. Bellingham, WA; SPIE Society of Photo-Optical Instrumentation Engineers (1983). (CONF-8310172—). Contract AC02-78EV04733.

From Advances in soft x-ray science and technology conference; Upton, NY, USA (17 Oct 1983).

It is now clear that the initial geometrical distribution of primary radiation products in irradiated biological matter is fundamental to be observed end-point (cell killing, mutation induction, chromosome aberrations, etc.). In recent years much evidence has accumulated, indicated that, for all radiations, physical quantities averaged over cellular dimensions (micrometers) are not good predictors of biological effect, and that energy deposition processes at the nanometer level are critical. Thus irradiation of cells with soft x rays whose secondary electrons have ranges of the order of nanometers is a unique tool for investigating different models for predicting the biological effects of radiation. The authors demonstrate techniques whereby the biological response of the cell, and the physical details of the energy deposition processes may be separated or factorized, so that given the response of a cellular system to, say soft x rays, the response of the cell to any other radiation may be predicted. The special advantages of soft x rays for eliciting this information and also information concerning the geometry of the radiation sensitive structures within the cell are discussed.

## 5603 Chemicals Metabolism And Toxicology

*REFER ALSO TO CITATION(S) 21062, 21065, 21120, 21130, 21143, 21209*

21228 **(CONF-870435—2) Dose-response models for energy-based pollutants.** Jones, T.D.; Walsh, P.J. (Oak Ridge National Lab., TN (USA). Health and Safety Research Div.). 1987. Contract AC05-84OR21400. 9p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87000393.

From Energy '87: energy solutions today for the nineties; Atlantic City, NJ, USA (27 Apr 1987).

Production of energy results in increased levels of environmental pollutants, both radioactive and chemical. Pollutants may

result from the manufacture of materials for production facilities, consumption of fossil or nuclear fuels, or leakage and spills associated with energy or chemical distribution systems. Two risk assessment problems common to all energy options include: the analysis of dose-response type information in test animals (considered to be reasonable analogues of man) and the use of disease rates in animals tested at very high doses to assess how man might be impacted when concentrations in food, water, and air are lower than experimentally tested doses by several orders of magnitude. An additional problem is that, in fossil-based systems, chemical compounds and complex mixtures are so numerous that a few reference chemicals must be used to consider health and safety issues deriving from thousands of chemical compounds and complex mixtures. Thus, benzo(a)pyrene is often taken as an index for polynuclear aromatic hydrocarbons; benzene for aromatic hydrocarbons and organic volatiles; benzidine for aromatic amines; and chromium (VI) for trace metals. This paper presents new ways to interpret large volumes of biological test data from many diverse experimental designs and demonstrates how this understanding can be coupled to risk factors derived from epidemiology. Dose-response estimates of human risk (resulting from a 50-year exposure period) are given for concentrations of benzo(a)pyrene, benzene, benzidine, and chromium (VI) ranging from 1 pg/m$^3$ to 1 $\mu$g/m$^3$.

21229 **(INIS-mf—10297) Summary introduction to environmental toxicology. Information paper.** Heinzow, B.; Jessen, H.; Wendorff, D. (Untersuchungsstelle fuer Umwelttoxikologie des Landes Schleswig-Holstein, Kiel (Germany, F.R.)). 1986. 41p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751270.

The increasing environmental consciousness and the increasing public interest in environmental medicine and toxicology is much appreciated by the Research Institute for Environmental Toxicology. This information brochure gives the reader some insight into the importance of environmental toxicology and into the work of the Research Institute. In response to the current situation, the authors have included an appendix on radiation protection.

21230 **(NP—7751620) Second report of the Research Committee on Forest Damage and Air Pollution of the Federal German Government and the Laender.** (Forschungsbeirat Waldschaeden/Luftverunreinigungen der Bundesregierung und der Laender (Germany, F.R.)). May 1986. 265p. (In German). NTIS (US Sales Only), PC A12/MF A01. File Number DE87751620.

In its second report, the Research Committee on Forest Damage pays attention mainly to questions relating to types of damage, causes, and the current state of knowledge in biologic research. The statements made by the committee on technical questions of clean air in its December 1984 interim report continue to hold good. Forest damage in West Germany has increased from 1984 to 1985 at a distinctly slower pace compared with the previous years if an average of all tree types is considered (possibly due in part to climate). But in areas of already severe damage (especially the Bavarian Alps and the upper part of medium-range mountains) a further deterioration is noted. Only in isolated cases was a die-off of entire stands recorded. The fir continues to be the species most seriously damaged. A marked increase in damage was observed in oak-trees, which now no longer differs greatly from the other main tree species in degree of damage. The committee on forest damage holds that its statements of 1984, in studying the causes of the new type of forest damage, on the part played by air pollutants have been largely confirmed. The committee repeat their recommendations to further reduce anthropogenic air pollutants. They further recommend to pay attention to reactive gases (hydrocarbons and aerosols) not sufficiently considered to date.

21231 **(PB—87-125969/XAB) Mortality among workers exposed to cutting fluids and abrasives: Bearing Plant 1.** Park, R.; Silverstein, M.; Maizlish, N.; Mirer, F. (International Union, United Automobile, Aerospace and Agricultural Implement Workers of America, Washington, DC). 30 Sep 1984. 72p. NTIS, PC A04/MF A01.

See also PB—86-221835.

A survey of mortality among United Automobile Union workers exposed to cutting fluids and abrasives was conducted. The cohort consisted of all hourly employees with 10 or more years of service who died from January 1, 1969 to July 31, 1982. A total of 702 death certificates and job histories of 768 employees were reviewed. Data was obtained from company and union records. Standardized proportional mortality ratios (PMR) were computed. Significant excesses of mortality from rectal cancer (PMR at 3.04), stomach cancer (PMR at 1.98), and stroke (PMR at 1.35) were found. A 25% elevation in mortality for lung cancer (PMR at 1.25) occurred among white males. Among females employed as grinders, the PMR for lung cancer was 2.8. A statistically significant correlation between stomach cancer and grinding exposure occurred. The grinding exposures consisted primarily of aerosols from soluble oil and oil-based metal working fluids. The authors note that the pattern of stomach cancer suggests a correlation with water-based cutting fluids.

21232 **(PB—87-131678/XAB) Toxicology and carcinogenesis studies of marine diesel fuel and JP-5 navy fuel (Case No. 8008-20-6) in B6C3F1 mice (dermal studies). Technical report series.** (National Toxicology Program, Research Triangle Park, NC (USA)). Sep 1986. 199p. (NTP-TR—310). NTIS, PC A09/MF A01.

Toxicology and carcinogenesis studies were conducted by applying marine diesel fuel or JP-5 navy fuel to clipped dorsal interscapular skin of male and female B6C3F1 mice to determine both systemic and dermal effects. Doses for the 2-year studies were set by conducting 14-day and 13-week studies. Doses of 2000-40,000 mg/kg marine diesel fuel were applied neat in the 14-day studies; in the 13-week studies, doses of 250-4000 mg/kg marine diesel fuel in acetone were applied with a dose volume of 0.1 ml. Doses of 5000-40,000 mg/kg JP-5 navy fuel in ethanol were applied in the 14-day studies with a dose volume of 0.5 ml; in the 13-week studies, doses of 500-8000 mg/kg JP-5 navy fuel in acetone were applied with a dose volume of 0.2 ml. For the 2-year studies, doses were selected which did not cause deaths, decrease body weight gain, or produce excessive dermatitis in the 14-day or 13-week studies. Under the conditions of these 2-year dermal studies, marine diesel fuel at doses of 250 and 500 mg/kg resulted in dose-related increased incidences of squamous-cell neoplasms of the skin (primarily carcinomas), providing equivocal evidence of carcinogenicity for male and female B6C3F1 mice. The sensitivity for detecting systemic carcinogenicity in female mice dosed with marine diesel fuel was reduced by poor survival. Under the conditions of these 2-year dermal studies, JP-5 navy fuel at doses of 250 and 500 mg/kg provided no evidence of carcinogenicity for male and female B6C3F1 mice.

21233 **(PB—87-133278/XAB) Lifetime carcinogenesis studies of amosite asbestos (Case No.121-72-73-5) in Syrian golden hamsters (feed studies). Technical report series.** (National Toxicology Program, Research Triangle Park, NC (USA)). Nov 1983. 81p. (NTP—81-58). NTIS, PC A05/MF A01.

Also published as National Toxicology Program, Research Triangle Park, NC. rept. no. NTP-TR-249.

Carcinogenesis studies of amosite asbestos were conducted by administering diets containing 1% of the asbestos in pellets from the conception of the mothers through the lifetime of male and female Syrian golden hamsters. Control groups consisted of 127 male and 126 female hamsters and the amosite asbestos group consisted of 252 male and 254 female hamsters. No adverse effect on body-weight gain or survival was observed from treatment with amosite asbestos. Neither of the amosite asbestos groups showed increased neoplasia in any organ or tissue compared to the control groups. Under the conditions of these studies, the ingestion of amosite asbestos at a level of 1% in the diet for their lifetime was not toxic and did not cause a carcinogenic response in male and female Syrian golden hamsters.

21234 **Studies of the temporal and spatial distribution of aerosols in multi-tiered inhalation exposure chambers.** Yeh, H.C.; Newton, G.J.; Barr, E.B.; Carpenter, R.L.; Hobbs, C.H. (Inhalation Toxicology Research Institute, Albuquerque, NM). *American Industrial Hygiene Association Journal;* 47: No. 9, 540-545(Sep 1986). Contract AC04-76EV01013.

Two multi-tiered whole body inhalation exposure chambers with nominal volumes of 1 m$^3$ (H-1000) and 2 m$^3$ (H-2000) were

evaluated for their performance in terms of the temporal and spatial distribution of test aerosols within the chamber. Parameters investigated included chamber type, single-chamber-single-aerosol generator versus two-chamber-single-aerosol generator systems, chamber air supply and exhaust systems, particle size, and aerosol diluter type. Results indicated that: 1) particle size has an effect on chamber aerosol concentration distribution, with the larger particle resulting in a higher variation; 2) the single-chamber-single-generator system is more stable than the aerosol distribution within the chamber could be improved with the use of a newly designed diluter.

21235 **PCB intake and the growth of waterfowl: multivariate analyses based on a reparameterized Richards sigmoid model.** Brisbin, I.L. Jr.; White, G.C.; Bush, P.B. (Savannah River Lab., Aiken, SC). *Growth;* **50**: No. 1, 1-11(Spr 1986). Contract W-7405-ENG-36;AC09-76SR00819.

Multivariate analyses of the parameters of a modified Richards growth model were used to determine the effects of sex and varying levels of dietary intake of PCB's (0-50 ppm), on the asymptotic size (W/sub infinity/), total growing time (T) and shape (m) of the growth curves of game farm mallards (Anas platyrhynchos) and wild wood ducks (Aix sponsa) raised under laboratory conditions. Level of PCB intake did not affect any of the growth parameters of the wood ducks, while sex affected both m and W/sub infinity/, with males of this species growing to greater body weights and showing slightly lower shape parameters than females. Growth characteristics of the mallards on the other hand, did not differ between the sexes. PCB intake however, had a significant effect on the shape of the mallard growth curve, but did not affect either W/sub infinity/ or T. All interactions between sex and PCB treatment level were non-significant in both species. The growth responses of game-farm mallards to PCB intake cannot be assumed to typify that of other wild waterfowl species without additional evidence from comparative studies.

21236 **Ambiguous carcinogens and their regulation.** Weinberg, A.M.; Storer, J.B. (Oak Ridge Assoc Univ., Oak Ridge, TN). *Risk Analysis;* **5**: No. 2, 151-156(Jun 1985).

Examination of five animal and one human studies suggest that certain agents increase the incidence of some cancers but simultaneously reduce the incidence of other cancers. Yellow die #3, for example, sharply increases the incidence of liver tumors but practically eliminates naturally occurring leukemia/lymphoma in F-344 male rats. Such ambiguity in the action of presumed carcinogens suggests that caution must be used by regulatory bodies in proscribing suspected carcinogens, or even in recommending changes in lifestyle or dietary habits as a means of reducing incidence of cancer.

21237 **"Ambiguous carcinogens"-another look.** Cumming, R.B. (Oak Ridge National Lab., Oak Ridge, TN). *Risk Analysis;* **5**: No. 2, 157-160(Jun 1985).

The Biology Division of the Oak Ridge National Laboratory discusses Weinberg and Storer's controversy about the proper use of data about "carcinogens" in the setting of public policy. The paper focuses attention on both the complexity of the environmental cancer problem, and on the simplistic, though practical way it is currently being handled by the health risk establishment. Weinberg and Storer suggest that because of the existence of "ambiguous carcinogens", regulatory rulemaking should be modified to focus less on the demonstration that an agent is or is not a "carcinogen" in a particular test system, and more on the total incidence of all cancers after an exposure. The author predicts that the carcinogen controversies will become more complex before the problem of regulating carcinogens can be solved.

### 5604 Other Environmental Pollutant Effects

21238 **Results of microwave oven radiation leakage surveys at Fermilab.** Miller, T.M. (Fermilab, Batavia, IL). *American Industrial Hygiene Association Journal;* **48**: No. 1, 77-80(Jan 1987).

This report describes the results of routine microwave oven leakage surveys which were conducted at Fermi National Accelerator Laboratory (Fermilab) between 1974 and 1985. A total of 80 ovens representing 250 oven-years of operation were examined. The mean maximum leakage at any point 5 cm from the surface was 0.20 x/ 3.1 $mW/cm^2$. Although there was a great deal of scatter in sequential measurements for individual ovens, it appears that leakage tends to increase with oven age. The mean logarithmic rate of increase for the 55 ovens with usable data was 0.21 per year. Case histories of ovens leaking in excess of the standard were examined, and improvements in leakage monitoring programs are suggested.

## 57 HEALTH AND SAFETY

21239 **(LA—10748) Evaluation of methods, instrumentation, and materials pertinent to quality assurance filter penetration testing: Final report.** Scripsick, R.C.; Soderholm, S.C. (Los Alamos National Lab., NM (USA)). Jan 1987. Contract W-7405-ENG-36. 142p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87006322.

Every high-efficiency aerosol filter used in United States Department of Energy (DOE) facilities is quality assurance tested at one of the DOE filter test facilities before installation. This testing presently includes measurement of filter penetration at rated and 20%-rated airflow using a thermal-aerosol generator, an Owl aerosol size analyzer, and a scattered-light-photometer aerosol concentration monitor. Alternative penetration measurement methods for testing size 5 high-efficiency aerosol filters, which have rated airflow capacities of ~28 $m^3$/min (1000 $ft^3$/min), were studied at Los Alamos National Laboratory. The methods studied take advantage of commercially available aerosol instrumentation and provide a more meaningful evaluation of the filters used in DOE facilities. A penetration test using a polydisperse aerosol, produced with a modified Laskin-nozzle aerosol generator, a laser aerosol spectrometer for aerosol size and concentration measurements, an aerosol diluter, and a microcomputer, is recommended as an alternative to the present test method. Such a test eliminates the difficulty in producing a monodisperse challenge aerosol, takes advantage of state-of-the-art aerosol sizing instruments, and can provide more detailed information regarding filter performance. Potential alternatives to di-(2-ethylhexyl)phthalate are also discussed. 86 refs., 38 figs., 5 tabs.

## 58 GEOSCIENCES

### 5801 Geology And Hydrology

*REFER ALSO TO CITATION(S) 19923, 20077, 20078, 20079, 20080, 20081, 20082, 20083, 20084, 20085, 20086, 20087, 20088, 20089, 20090, 20091, 20092, 20093, 20094, 20095, 20096, 20097, 20131, 20170, 20171, 20302, 20735, 21129*

21240 (DOE/ER/60152—1-Pt.2, pp 585-595) **Regional groundwater sampling for the assessment of fluid movement.** Alexander, J. (British Geological Survey, Keyworth, England). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

On a regional scale groundwater flow is considered to take place within high permeability lithologies which are bounded by low permeability strata often designated as impermeable. These are the sort of environments proposed for feasibility studies for nuclear waste disposal which present problems in terms of choosing relevant groundwater sampling locations and subsequent data interpretation. Hydrogeological studies of a sequence of gently dipping clays and limestones in central England, suggest that cross-formational flows have a major influence on groundwater chemistry and provenance. The hydrogeochemical study was based on the tenet that very slow groundwater movement is most easily observed by measuring time-related parameters, such as element chemistry, inert gas contents and stable isotopes, at widely separated measurement points within a sequence of high permeability lithologies. The occurrence and scale of cross-formational flow, particularly through the clay lithologies is being evaluated by long-term sampling of pressure heads and groundwater chemistry from clay formations in Oxfordshire. Basic chemistry, natural series isotopes and dissolved

gas contents measured from fluids in these low flow environments are expected to substantiate the model of inter-lithology water movement in general and vertical water movement across clay lithologies in particular. 10 references, 4 figures, 1 table.

21241 (DOE/ER/60152—1-Pt.2, pp 631-638) **Artificial recharge techniques in basaltic rocks of low permeability from peninsular India.** Thigale, S.S. (Univ. of Poona, India). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Basaltic rocks of the Deccan Volcanic Province are known for their low permeability. The Province is characterized by semi-arid climate, unpredictable rainfall pattern and variable topographic and hydrogeological conditions. Consideration of artificial recharge techniques has, therefore, gained significance in the Province. Construction of percolation taken across streams, on weathered, jointed or vesicular basalts, has been a common practice of artificial recharge during the last two decades. Construction of subsurface dams, on the other hand, is a comparatively new technique which arrests the subsurface flow of water for improving groundwater storage in the upstream area. Both the techniques have not only assisted in increasing the yield of the wells and subsequently solving the drinking water problem but have also led to favorable changes in agricultural land use pattern by bringing more land under well irrigation. 14 references, 4 figures.

21242 (DOE/ER/60152—1-Pt.2, pp 639-649) **Comparison of under-pressure and over-pressure pulse tests conducted in low-permeability basalt horizons at the Hanford Site, Washington state.** Thorne, P.D.; Spane, F.A. Jr. (Pacific Northwest Lab., Richland, WA). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Over-pressure pulse tests (pressurized slug tests) have been widely used for hydraulic characterization of low-permeability ($<10^{-8}$ m/s) rock formations. Recent field studies of low permeability basalts horizons at the Hanford Site, Washington, indicate that the under-pressure pulse technique is also a viable test method for hydraulic characterization studies. For over-pressure pulse tests, fluid within the test system is rapidly pressurized and the associated pressure decay is monitored as compressed fluid within the test system expands and flows into the test formation. Under-pressure pulse tests are conducted in a similar manner by abruptly decreasing the pressure of fluid within the test system and monitoring the associated increase in pressure as fluid flows from the formation into the test system. Both pulse test methods have been used in conjunction with the other types of tests to determine the hydraulic properties of selected low-permeability basalt horizons at Hanford test sites. Results from both pulse test methods generally provide comparable estimates of hydraulic properties and are in good agreement with those obtained from other hydrologic tests. 13 references, 6 figures, 3 tables.

21243 (DOE/ER/60152—1-Pt.2, pp 658-665) **Water potential of the deep aquifers in the Negev Desert, Israel.** Nativ, R. (Ben Gurion Univ. of the Negev, Beer Sheva, Israel). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The deep aquifers (Jurassic to Paleozoic, 1-5 km depth) underlying the Negev and Sinai Deserts contain brackish to saline water. The objective of the study of these aquifers was the evaluation of their water potential for irrigation and industrial consumption, as well as their potential to serve as host rocks for hazardous waste burial. A conceptual model for this thick sequence of layers, having different lithologies, that are probably hydraulically connected was constructed. This included elimination of pressure and salinity data that had been obtained under improper conditions and analysis of tests that had never been analyzed before or had been interpreted incorrectly. The conceptual model was examined carefully for its consistency from different aspects such as pressures, permeabilities, salinities, temperatures, and isotopic distribution; all had to lead to the same suggested pattern for the flow model. Data were scarce and hydraulic parameters were estimated by linear regression for places where no data existed. Because of large differences in salinities, the mathematical model had to include a mass balance equation as well as a volume balance equation. The numerical scheme was developed to solve these equations and predict water levels and salinities in these aquifers for different management policies. 4 references, 4 figures.

21244 (DOE/ER/60152—1-Pt.2, pp 666-675) **Numerical model for transport in networks of planar fractures.** Smith, L.; Mase, C.W.; Schwartz, F.W.; Chorley, D. (Univ. of British Columbia, Vancouver). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

A finite element model has been developed to simulate fluid flow and mass transport in a network of intersecting planar fractures. Fractures are assumed to be rectangular in shape. The geometry of the network is described probabilistically. Nodal points located at fracture intersections provide the linkage for assembling the finite element equations for each fracture plane into one global matrix for the entire network. Solution of the system of equations is carried out using an iterative technique with storage of only the non-zero elements in the lower band of the coefficient matrix. A moving particle technique is used to simulate mass transport. With this approach, it is possible to model reasonably large systems. Examples are presented to demonstrate the influence of the number of fractures forming the network and fracture orientation on the breakthrough of mass at a downstream boundary. 17 references, 6 figures.

21245 (DOE/ER/60152—1-Pt.2, pp 676-682) **Numerical experiments on artificially-generated, three-dimensional fracture networks: an examination of scale and aggregation effects.** Rasmussen, T.C.; Huang, C.H.; Evans, D.D. (Univ. of Arizona, Tucson). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The recent development of a fully three-dimensional fracture network generation technique allows, for the first time, the user to analyze flow through fractured rock for the purposes of estimating in situ hydraulic conductivity and for examining effects of scale on a measurement. Previous investigators have been limited to applications involving two-dimensional transport. The new technique also allows the user to utilize site-specific information to generate a representative sample of rock in a statistical sense. While the generated sample will not exactly replicate any actual sample of rock, it will appear as though it had been selected from the location of interest. Extensions to unsaturated flow regimes are demonstrated by assuming the validity of capillary theory. Using this theory, a hypothetical moisture characteristic curve is used to drain relevant fractures. Plots of fluid potential vs. global hydraulic conductivity are presented. The computer simulation model is used to show how the measurement scale affects estimated hydraulic conductivity. It is demonstrated that, as the scale of the measurement is increased the coefficient of variation of the global hydraulic conductivity, C/sub v/, decreases. The implications of this result are important for determining the scale at which equivalent porous media, EPM, models are suitable and for identifying the level of sampling sufficient for site characterization.

21246 (DOE/ER/60152—1-Pt.2, pp 695-705) **Analysis of unsteady ground water flow in a stream-confined fractured aquifer system.** Oender, H.; Gueray, M. (Middle East Technical Univ., Ankara, Turkey). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

A confirmed fractured aquifer of finite width L. bounded on one side by a stream and on the other by an impervious boundary is considered. The response of the aquifer to an arbitrarily varying stream stage is analyzed. Fractured formations usually contain the low permeable blocks of primary porosity separated by fractures of low fissure volume and of relatively high permeability. The conducting properties of the aquifer is associated mainly with the frac-

ture permeability while the storage properties are related to the primary porosity of the blocks. Based on the double porosity conceptual model, governing equations of the flow within the blocks and the fractures are given. Using the convolution relation, variations in piezometric head of the flow within the blocks and fractures due to an arbitrarily varying stream stage are obtained. The equations of ground-water flow and bank storage that would occur in the aquifer are also given. Application to a hypothetical aquifer reveals that the response of the fractures aquifer to the fluctuations in the stream stage is much slower than that of conventional granular aquifers. It is concluded that the presence of blocks and fractures modifies substantially the flow behavior in conventional aquifer. It is also noted that the obtained equations may be of use to determine the aquifer characteristics from the analysis of the observed response of the aquifer. 11 references, 6 figures.

21247 (DOE/ER/60152—1-Pt.2, pp 706-719) **Identification of permeability properties of rocks.** Yu-sun, C.; Ji, B. (Ministry of Urban and Rural Construction and Environmental Protection, Beijing, China). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

At present, in many hydrogeological computations such as ground water extraction, pumping test as well as ground water resources evaluation the fractured aquifer is generally treated as porous medium aquifer. Hence a theoretical problem occurs: whether the permeability coefficient of fractured aquifer identified by this approach could represent the permeability of rocks macroscopically? Theory of fluid mechanics has proved that water flow in fracture also follows the Darcy's law if the aperture is small enough, upon which a numerical model simulating ground water movement in fractured aquifer was developed by finite element method. In that model fracture system was simulated by two-dimensional isoparametric element and the rock matrix was simulated by three-dimensional ones. As an example the model is used to simulate a pumping and injection tests. The results of simulation were not only reasonable but also identical with the porous medium model. Hence it shows that the usual method used for determining the permeability coefficient of porous medium can be used for determining the macroscopic permeability coefficient of rock as well. 4 references, 8 figures.

21248 (DOE/ER/60152—1-Pt.2, pp 729-734) **Manifestation of ground water statics in thin and low permeability basaltic aquifer in India.** Limaye, D.G.; Limaye, S.D. (Geophysical Explorers, Poona, India). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The special hydrogeological features of the Basalts of western India (Deccan traps) are low permeability, large fluctuations in water table, small saturated thickness in summer months and effluent drainage towards streams and rivers during about eight months dry period of winter and summer. Under these conditions, the thin ground water body assumes a static or quasi-static stage in summer months, especially during a drought year. In this stage, the small gradient is not able to overcome the frictional resistance so as to cause flow of water in the low permeability strata. In classical mechanics, this case is somewhat similar to a body resting on a plane having inclination equal to or less than the angle of repose. Thus, although the streams, rivers and dug wells in basaltic terrain may dry up in summer the entire aquifer above such discharge points is not dewatered. Pockets of ground water body under static condition can be tapped in new wells excavated away from existing dry wells or streams. This paper discusses the concept of ground water statics based on field observations and its application. 5 references, 4 figures.

21249 (DOE/ER/60152—1-Pt.2, pp 735-740) **Groundwater exploration in northeast Gongola State, Nigeria using remote sensing.** Isiorho, S.A. (Case Western Reserve Univ., Cleveland, OH). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Standard black and white and false color composite LANDSAT and radar images of northeast of Numan, Gongola State, Nigeria were analyzed for groundwater exploration. The region studied is almost completely comprised of crystalline rocks. Linear features suspected of being fractures or faults were delineated using operational photogeological techniques. These linear features were plotted in rose diagrams from which areas were recommended for further field resistivity measurements, followed by drilling on the most favorable resistivity anomalies. 9 references, 4 figures.

21250 (DOE/ER/60152—1-Pt.2, pp 741-751) **Increased groundwater discharge caused by the 1983 Idaho (USA) earthquake.** Wood, S.H.; Wurts, C.; Lane, T.; Ballenger, N.; Shalleen, M.; Totorica, D.; Waag, C. (Boise State Univ., ID). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The October 28, 1983 Idaho earthquake (Ms = 7.3) greatly increased the groundwater discharge from springs over a region extending at least 90 km beyond the 34-km long zone of surface rupture at the west base of the Lost River Range. Many warm springs systems nearly doubled in flow, and one major spring increased 10 times its original flow. Numerous seeps became flowing springs. Major rivers draining a 18,000 $km^2$ significantly increased in flow for a period of several months following the earthquake, and at the time of writing (9/84) are still running high. In the 1160-$km^2$ upper Big Lost river drainage the increased flow for 6 months following the earthquake is equivalent to an 8 cm runoff event over the basin. It follows from Darcy's law that increased discharge must be attributed to either an increase in aquifer pressure or an increase in permeability along the flow path. Coseismic strain release should produce a contraction of volume in the rocks of the hanging-wall block of fault and consequently an increase in pore pressure. Increase in pore pressure might also be caused by compaction of aquifer rocks by seismic shaking or regional tectonic tilting of aquifers. Increase in permeability along previous spring conduits could be produced over a wider region by the flushing and cleaning of conduits by surging flows caused by seismic shaking. It is also possible that pore pressure pulses produced by the passage of seismic waves could produce natural hydraulic fracturing. 18 reference, 9 figures.

21251 (DOE/ER/60152—1-Pt.2, pp 761-772) **Dolomitic aquifer south east of Pretoria as an emergency ground water supply.** Bredenkamp, D.B.; Foster, M.B.J.; Wiegmans, F.E. (Dept. of Water Affairs, Pretoria, South Africa). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

A dolomitic aquifer in the vicinity of Pretoria and Johannesburg was investigated as a possible emergency ground water supply to alleviate shortages of surface water during severe droughts. The dolomitic aquifer investigated south east of Pretoria is separated from the main outcrop by a thrust fault, and divided by dykes into subcompartments. The siting of potential production boreholes was based on geological investigation and a gravity and magnetic survey. Areas of gravity lows and steep gradients on the Bouguer anomaly map were interpreted as zones of leached dolomite. An electromagnetic survey was conducted with the object of obtaining a more rapid means of identifying zones of leached dolomite but results were not conclusive and require further investigation. Drilling has shown that solution weathering can extend to a depth of 100 meters and yields up to 80 liter/second were obtained. The storage capacity of the dolomitic aquifer to a depth of 100 meters is of the order of 136 x $10^6$ $m^3$ assuming an effective porosity of 0,06. The average annual recharge was estimated at 2,3 x $10^6$ $m^3$ which is the equivalent of 100 mm of precipitation or 15% of the average annual precipitation. 7 references, 6 figures.

21252 (DOE/ER/60152—1-Pt.2, pp 773-780) **Hydrogeological investigation of crystalline rocks of the Bohemian Massif.** Skorepa, J.; Vrba, J. (Stavebni Geologie, Prague, Czechoslovakia). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Crystalline rocks of the Bohemian Massif form a major part of the territory of Czechoslovakia. Metamorphic crystalline schists of Proterozoic age with different intensity of metamorphosis form a major part the metamorphic complex and are accompanied by large scale bodies of plutonic rocks of Variscan age. A special methodology of hydrogeological investigation is being developed in the crystalline rocks area. Of special interest are the bodies of plutonic rocks and crystalline limestone both of which are hydrogeologically more perspective. The set of methods used for investigation is as follows: a) geotectonic data collection and statistical evaluation, b) geophysics, c) geohydrological measurements and observations, d) hydrochemical monitoring, e) investigation boreholes and pumping tests, f) special monitoring systems. With the use of these methods the probability of locating a ground-water source with a yield higher than .5 $ls^{-1}$ in bodies of plutonic rocks has increased from 25% to 70%. 2 references, 3 figures, 1 table.

21253 (DOE/ER/60152—1-Pt.2, pp 781-791) **Hydrogeology of the Gebel Uweinat - Aswan uplift system, eastern Sahara.** Schneider, M.; Sonntag, C. (Technical Univ. of Berlin, West Germany). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The basement uplift system between Gebel Uweinat and Aswan separates the Sudanese part of the Kufra Basin and the Selima Platform in the south from the Dakhla Basin in the north. The aquifer in the central part of each basin is buried under a cover of confining beds and crops out in the uplift area at the rim of the basins. Within the context of an extensive groundwater and agricultural project, located on this uplift system, more than 30 wells were drilled at 16 locations. Deuterium and oxygen-18 analyses show that the groundwater under investigation is of the same paleoclimatic origin as the fossil groundwater of the Dakhla Basin. The carbon-14 groundwater ages show that the groundwater was formed during the late Pleistocene and Holocene. The potential groundwater influx from north-western Sudan into the study area is estimated to be in the order of $4.4 \times 10^7$ $m^3$/year. Due to evaporation, the groundwater is enriched by the stable isotopes deuterium and oxygen-18 which indicates a considerable discharge. 26 references, 6 figures, 1 table.

21254 (DOE/ER/60152—1-Pt.2, pp 792) **Semi-quantitative measurement of water flow through fractured crystalline rock using the borehole-dilution technique.** Lee, D.R. (Chalk River Nuclear Labs., Ontario). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

In an effort to assess the discharge of bedrock groundwaters into Precambrian Shield lakes, measurements of water flow have been made using an adaptation of the classical borehole dilution technique. The significant adaptation was the emplacement of a 70 mm diameter metal cylinder in the 76 mm borehole test interval. The cylinder, which was straddled by two inflated packers, reduced the dilution volume by a factor of five and correspondingly reduced the time required for flow measurement. Field tests were performed within 30 m of the surface in a single borehole located near the intersection of a lineament and a lakeshore. Dilution rates in twenty-one, 1.1 m long, test intervals ranged from 0.2 to 118 mL per minute. These results were remarkable considering the low permeability of the rock. At dilution rates less than 20 mL per minute each borehole dilution test required 18 to 24 hours. At greater dilution rates satisfactory results could be obtained in 2 to 8 hours. These measurements were semi-quantitative because the effective porosity and the degree to which groundwater flow converges and diverges in the vicinity of the borehole test interval is not known.

21255 (DOE/ER/60152—1-Pt.2, pp 794) **Regional flow in the Dakota aquifer: a study of the role of confining layers.** Bredehoeft, J.D.; Neuzil, C.E.; Milly, P.C.D. 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The Dakota Sandstone in South Dakota is one of the classic artesian aquifers; it was first studied by N.H. Darton at the turn of the century. Since then, hydrogeologists have debated the source of the large quantities of water which have been discharged by artesian flow from the Dakota. Among suggestions for the source of this water are recharge of the aquifer at outcrops in the Black Hills; compactions and compressive storage within the aquifer; leakage through confining layers; and upward flow from the underlying Madison Group limestones. A series of increasingly refined models of the aquifer system in South Dakota have been developed and used for numerical simulations of the groundwater flow. The simulations have provided estimates of leakage through the confining layers. In situ and laboratory hydraulic conductivity measurements have been made for the cretaceous shale confining layer which overlies the Dakota. These data indicate hydraulic conductivities which are one to three orders of magnitude lower than the conductivities indicated by the numerical analyses; this suggests that the leakage through the confining layer is largely through fractures. To test the conception of flow in the aquifer-confining layer system derived from these analyses, the transport of sulfate in the system was simulated. This result increases confidence in the flow system implied by the flow simulations in which leakage through confining layers is dominant.

21256 (DOE/ER/60152—1-Pt.2, pp 796) **Impact of low permeable marine strata on groundwater and stream salinity in the upper Colorado River basin.** Duffy, C.J.; Sangani, S. (Utah State Univ., Logan). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The unique geology of the Upper Colorado River Basin plays a dominant role in determining the chemical quality of streams and rivers which cross the region. The near surface rocks of the basin are comprised of flat lying consolidated sediments of sandstone and shale which range from continental to marine origin. Groundwater occurs in both the unconsolidated and consolidated sediments, but because of the low permeability of the latter, active flow is observed only in the unconsolidated material. The preliminary research indicates that the mechanisms of salt release in the above setting are due to the displacement of dissolved salts in the alluvium by natural recharge and/or excess irrigation; dissolution of salts from partially weathered residuum or alluvium; and the vertical diffusion of salts from underlying consolidated marine deposits. The major goal of the present study is to examine the potential for diffusive transport of salts from shallowly buried marine deposits, and to estimate the significance of this process on groundwater and stream salinity. A field site was selected in the Price River Basin, a tributary to the Green and Colorado Rivers, since considerable subsurface data were available from a recently completed Bureau of Reclamation study. A two-dimensional vertical plane, finite element model was implemented to study flow and transport of dissolved salts in the stratified system.

21257 (DOE/ER/60152—1-Pt.2, pp 798) **Effective transport porosity of some fine-grained sediments.** Cartwright, K. (Illinois State Geological Survey, Champaign). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

In predicting the transport of tracers and contaminants in the groundwater system, a term describing the distribution of pore space must be used to modify the Darcy equation. Total porosity, effective porosity and specific yield have all been used to describe the ratio of pore space to solid rock to calculate transport rates. In coarse-grained sediments the error introduced appears to be small. However, the difference between total porosity and effective porosity or specific yield in fine-grained sediments is large. Specific yield is often used in practice as an approximation of effective porosity, even though they are physically very different terms. Total porosity and specific yield of fine-grained sediments are relatively easy to determine; effective porosity can also be determined, though with more difficulty. Neither of these terms accurately described the effective pore volume or effective transport porosity. A series of experiments were conducted on fine-grained glacial tills to examine

the relationship of effective transport porosity to effective porosity, specific yield, and total porosity. In general, specific yield provided values too small and total and effective porosity values are large. The concept of effective porosity may also be applicable in describing tracer and contaminant transport in some sediments with secondary permeability.

21258 (DOE/ER/60152—1-Pt.2, pp 799) **Role of environmental isotopes and geochemistry in studying rocks of low permeability - with applications to semi-arid areas.** Hess, J.W.; Jacobson, R.L. (Univ. of Nevada System, Las Vegas). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Low permeability rocks in semi-arid areas are particularly difficult to study because of low recharge and therefore low flux through the systems. This usually mandates longer studies with greater uncertainties. In this arena, environmental isotopes (deuterium, oxygen-18, carbon 13 and 14, tritium and sulfur-34) and geochemistry are appealing because the rock matrix may be examined in several independent ways and the results compared. The primary objective was to get a better handle on evaporative losses using soil waters, and resultant tree and groundwaters. These techniques have been tested in several areas and demonstrate that much of the recharged water has not undergone any evaporation, and the oxygen-18 and deuterium data indicate cold precipitation is responsible for most recharge. Time-series sampling of ground waters, from various locations during several studies, have also proved as an aid in understanding the hydrologic system. By comparing the variations in spring discharge or well water levels, water chemistry, and environmental isotopes, it is possible to estimate flow rates, timing of recharge, flow directions and other important hydrologic characteristics. The ages of groundwaters have also been investigated using tritium and carbon-14. Primary emphasis has been undeveloping techniques to correct apparent carbon-14 age dates in semi-arid areas.

21259 (DOE/ER/60152—1-Pt.2, pp 801) **Comparison of hydraulic properties of fractured dolomite determined by pressure pulse, slug/bailer, and pumping tests.** Kuhn, M.W.; Stensrud, W.A.; Walter, G.R. (Hydro Geo Chem, Inc., Tucson, AZ). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Theoretical and intuitive arguments suggest that the validity of field tests to determine the hydraulic conductivity of fractured rocks will depend on the volume of rock affected by the particular testing method. While time and monetary constraints usually favor the use of pressure-pulse or slug/bailer techniques for single-hole tests in tight rocks, the validity of such tests is often challenged because these tests have a small radius of influence and their analysis is based on porous media models. For these reasons, pump tests are often favored, when time and money permit, because of their large radius of influence and the availability of analytical techniques for handling discrete fracture responses. This paper compares the results of pressure-pulse, slug/bailer, and pump tests performed on several different wells completed in the Culebra Dolomite at the Waste Isolation Pilot Plant, Southeastern New Mexico. Although independent geologic and tracer test data suggest that groundwater movement takes place primarily through systems of fractures of solution channels, agreement was found between hydraulic conductivities determined on the same well using the different hydraulic testing procedures. These tests were performed on wells with transmissivities ranging from $4 \times 10^{4}$ to $1 \times 10^{-9}$ $m^2/s$ and no consistent differences between the techniques were observed. This work has been performed by Hydro Geo Chem, Inc., under contract to Sandia National Laboratories, Document No. 74-2700B.

21260 (DOE/ER/60152—1-Pt.2, pp 802) **Hydraulic properties of the Pierre Shale a comparison of methods.** Summers, W.K. (W.K. Summers & Associates, Inc., Socorro, NM). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

At a 900-acre site in Colfax County, New Mexico, weathered and unweathered Pierre Shale of Cretaceous age underwent extensive testing including the drilling of both vertical and angle test holes and consequent work that included two bore-hole geophysical surveys, pressure injection tests of 8 core holes, slug tests of 23 piezometers and 2 core holes, a pumping test, and laboratory tests of 10 cores. This paper describes and evaluates 8 methods used to analyze the slug tests and demonstrates the virtuosity of a method devised by Baumer and Rice (1976). Second, it presents and compares the results obtained for matrix and fracture hydraulic conductivity and for porosity and specific storage. The most likely average value for the matrix hydraulic conductivity is $10^{-3}$ ft/day. The test drilling, slug tests, and the pumping test indicate the presence of widely spaced fractures both vertical and horizontal fractures - in the shale. The fractures give the shale an effective hydraulic conductivity that is in the range of 0.2 - 0.6 ft/d.

21261 (DOE/ER/60152—1-Pt.2, pp 806) **Use of remote techniques to interpret the hydrogeology of an interior basin near Ibri, Sultanate of Oman.** D'Lugosz, J.J. (Office of Surface Mining, Denver, CO). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

Oman, being one of the most arid countries in the world, needs ground water to fulfill the long-term goals established by the Sultan, H.M. Qaboos Bin Saud Bin Taimur. Since 1978 there has been an increased emphasis on defense within the sultanate. This led to a ground-water study in an interior basin near the village of Ibri. This area is very isolated, so intensive field investigations prior to drilling were difficult to complete within the time constraints of the project. Instead of field investigations, the entire drilling program was based on satellite imagery analysis to define potential areas for ground-water production. Individual basins were identified for production potential based on estimated hydraulic characteristics of the wadi alluvium. The overall success of the program showed that ground-water parameters can be predicted in a very arid environment using remote sensing techniques. Aquifer test data indicated that there was enough water in storage to satisfy demands for several hundred years. As a result, a Ministry of Defense camp, which has a high water use, was established in an area that presumably had little ground-water potential.

21262 (DOE/ER/60152—1-Pt.2, pp 807) **Ground water exploration in metamorphic rocks, Koolan and Cockatoo Islands, western Australia.** Bar-Joseph, J. (Tahal Consulting Engineers, Israel). 1985. NTIS, PC A19/MF A01. File Number DE87005740. (CONF-850101—Pt.2).

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

The Yampi Sound and its islands formed part of the precambrian metamorphic region (The Kimberly), separated now by narrow straits and channels from the main continent. Rich iron ore deposits were discovered within the folded structures of metamorphic rocks (quartzites, schists and hematite sandstones) and are mined by the Australian company Dampier Mining Ltd. The small communities based on Dampier employees and families (nearly 1000 persons on both islands) are confronted with serious water supply problems to fulfill their domestic demands (6000 $m^3$/week for Koolan Island and 1800 $m^3$/week for Cockatoo Island). In the past, fresh water was totally imported by shipping from the mainland at a very high cost. The author of this paper has conducted very careful and detailed hydrogeological studies on both islands during one year. The studies revealed close relationships between the geological structure, jointing, bedding planes and cleavage, with the occurrence and development of high permeability and conductivity zones. Fractured quartzites and hematite sandstones, underlain by impermeable schists and folded in synclinal structures were found to be good local aquifers. Wells drilled along the synclinal axis showed good results and relatively high yields, 25-30 $m^3$/hr. Transmissivity changes from 10 $m^3$/day to 80 $m^3$/day. Fresh water bodies were located in depths of 80-100 m' below sea level. Sea water intrusion, as well as affect of high ocean tides (6-10m') were not observed in those structures.

21263 **(LBL—22794) A new seismic-hydraulic approach to modeling flow in fractured rocks.** Witherspoon, P.A.; Long, J.C.S.; Majer, E.L.; Myer, L.R. (Lawrence Berkeley Lab., CA (USA)). Jan 1987. Contract AC03-76SF00098. 37p. (CONF-870252—6). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006143.

From Solving ground water problems with models conference; Denver, CO, USA (10 Feb 1987).

Modeling flow of ground water in fradevice. A model of wavetured rocks is a major problem. This paper summarizes a program of investigations currently underway in this laboratory to characterize the geometry of fractured rocks and develop methods of handling flow in such systems. Numerical models have been developed to investigate flow behavior in two- and three-dimensional fracture networks. Two-dimensional studies of fracture interconnection indicate that systems with shorter fracture lengths have smaller permeabilities and behave less like porous media than those with longer lengths. Studies of transport indicate that the effects of increasing the coefficient of variation of aperture are opposite to those of increasing the correlation between length and aperture. Studies of scale and boundary effects indicate that the size of the representative elementary volume for homogeneously fractured systems may only be a function of fracture frequency. These are some examples of the insights to be gained from modeling studies of fractured rocks. A key problem is gathering the necessary data on fracture geometry. Investigations have been started to determine how vertical seismic profiling (VSP) might be improved and applied to this problem. According to theory, a fracture can have a significant effect on shear wave propagation in rock systems. Laboratory measurements show a significant attenuation of shear waves as fracture stiffness decreases and frequency increases. A VSP experiment in The Geysers geothermal field where fracture orientation is known, produced shear wave splitting and velocity anisotropy in agreement with theory. The results suggest the potential application of 3-component, multi-source VSP data in determining fracture orientation and average spacing. A downhole seismic wave generator would greatly improve VSP, and we are developing such a device.

21264 **Aquifer test analysis in nonradial flow regimes: a case study.** Smith, E.D.; Vaughan, N.D. (Oak Ridge National Lab., TN). *Ground Water;* **23**: No. 2, 167-175(Mar-Apr 1985). Contract AC05-84OR21400.

A low-rate aquifer pumping test was conducted in a folded and fractured limestone formation in the Conasauga Group of East Tennessee. An elongate drawdown pattern was observed suggesting that pumping response was controlled by a highly conductive zone associated with a pair of anticlinal folds that bisect the test site. The solution technique used to estimate aquifer parameters treats the fold axes as a highly conductive vertical fracture in an anisotropic matrix of much lower hydraulic conductivity. The complexity of both the site and the solution technique necessitated iterative trial-and-error variable substitution to estimate aquifer parameters. The resulting solution includes estimates of matrix transmissivity in two directions, the storage coefficient of the matrix, and the effective length and location of the master fracture. Estimates of hydraulic parameters lack the apparent precision of values that would be generated by radial flow techniques, but they are consistent with geologic conditions at the site and present a clearer picture of the hydrogeologic regime than could be obtained with other investigative techniques. The solution technique used makes it possible to interpret the results of aquifer tests in complex hydrogeologic settings. This and related analytical techniques for other nonradial flow situations may prove useful in other hydrogeologic investigations in low-permeability media affected by folds, faults, fractures, or solution channels. 23 references, 7 figures, 2 tables.

21265 **End of the Cretaceous: sharp boundary or gradual transition.** Alvarez, W.; Alvarez, L.W.; Asaro, F.; Michel, H.V. (Univ. of California, Berkeley). *Science (Washington, D.C.);* **223**: 1183-1186(16 Mar 1984).

Evidence indicates that the Cretaceous-Tertiary boundary is very sharp, and, within the limits of resolution, it is apparently synchronous at the various boundary localities. Arguments to the contrary, particularly those of Officer and Drake, are shown to be invalid. 35 references, 2 figures.

21266 **Experimental evidence that an asteroid impact led to the extinction of many species 65 million years ago.** Alvarez, L.W. (Lawrence Berkeley Lab., CA). *Proceedings of the National Academy of Sciences of the United States of America;* **80**: 627-642(Jan 1983).

An overview is presented of the theory that an asteroid hit the earth 65 million years ago wiping out large numbers of land and marine species. This theory predicts that the clay layer found at the boundary of the Cretaceous and Tertiary Periods would be substantially different chemically from the clays in the limestone above and below the boundary layer. It also predicts the iridium enhancement seen in this boundary layer would be found worldwide. Both predictions have been found to be true. A third prediction was made but not fulfilled: that the five major extinctions which occurred in the last 570 million years were caused by an asteroid impact. The transport mechanism of the dust created by the impact and four mechanisms for the extinction of species are discussed. Criticisms of the theory are also discussed.

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*REFER ALSO TO CITATION(S) 19965, 19974, 20295, 20304, 21048, 21263*

21267 **(AD-A—175432/4/XAB) User's manual for finite-difference synthetic seismogram codes on cyber 205 and cray XMP-12. Technical Memorandum.** Hunt, M.M.; Stephen, R.A. (Woods Hole Oceanographic Institution, MA (USA)). Nov 1986. 45p. (WHOI—4-86). NTIS, PC A03/MF A01.

A software package was developed to solve the elastic-wave equation by the method of finite differences. The elastic wave equation can be solved in two dimensions for point sources in cylindrical coordinates or line sources in rectangular coordinates. Compressional and shear velocity and density are allowed to vary both vertically and radially. Since the code is very computationally intensive for realistic size models, it has been implemented on two Class VI supercomputers: the Cyber 205 at Purdue Univ. and the Cray XMP-12 at NRL. This technical technical report is a user's manual for running the code on these machines. (It is assumed that the reader is already familiar with running the code on the VAX 11-780.)

21268 **(DOE/ER/13472—1) Two and three-dimensional inversion of magnetotelluric data: Annual performance report.** Booker, J.R. (Washington Univ., Seattle (USA). Dept. of Geophysics). 15 Jan 1987. Contract FG06-86ER13472. 50p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005553.

Structure in terms of norms of the derivative of the conductivity ($\sigma$) or log$\sigma$ with respect to a function of depth are measured. Models that minimize these norms for chosen levels of chi-squared misfit are found, using an iterative linearized algorithm. In most cases, the models found are very likely the global minima of these norms, as they do not depend on the starting model. It is demonstrated that overfitting data requires extraneous structure. Some choices of the depth function result in systematic overfitting of high frequencies, a 'blue' fit, and extraneous shallow structure. Others result in systematic overfitting of low frequencies, a 'red' fit, and extraneous deep structure. A robust statistic is used to test for whiteness, and show how to make the fit acceptably white by varying the depth function that defines the norm. Using artificial data, it is shown that the optimum norm produces an inversion which does not introduce false structure and which approaches the true structure in a reasonable way as data errors decrease. For models of $\sigma$ (but not log$\sigma$) linearization errors are often so small that models may be reasonably interpreted as the true conductivity averaged through known resolution functions. 18 refs., 13 figs., 3 tabs.

21269 **(NUREG/CR—4685) Post-Pliocene displacement on faults within the Kentucky River Fault System of east-central Kentucky.** VanArsdale, R.B.; Sergeant, R.E. (Kentucky Geological Survey, Lexington (USA); Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Safety). Feb 1987. 44p. NTIS, PC A03/MF A01 - GP0. File Number TI87900534.

The Kentucky River Fault System forms the northern boundary of the Rome Trough (a Paleozoic aulacogen) in east-central Kentucky. Paleozoic recurrent movement along this fault system has been documented by a number of previous workers; however, recognition of Mesozoic and early Tertiary displacement has not been possible due to the absence of preserved post-Paleozoic strata. Numerous faults of the Kentucky River Fault System are partially overlain by Pliocene-Pleistocene terrace deposits along the Kentucky River. Results from preliminary drilling and electrical-resistivity surveys indicate that a number of these faults may have been active since deposition of terrace materials. Based on indications from these preliminary surveys, fours sites were selected and nine trenches were excavated. Of these nine trenches, four revealed faulted or folded terrace sediments. Comparison of the nine trenches suggests that the folding and faulting of the terrace deposits is tectonic in origin and that the Kentucky River Fault System has been active within the last 5 million years, and probably within the last 1 million years.

21270 **(UCID—20985) LLNL digital seismic data acquisition system manual.** Jarpe, S.; Rock, D.; Johnston, C.; Ewert, D.; Wethern, L. (Lawrence Livermore National Lab., CA (USA); NEWT, Inc., Seattle, WA (USA)). Feb 1987. Contract W-7405-ENG-48. 49p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006308.

This manual describes the computer interface, set-up and checkout of remote field stations, and the central data acquisition system. (ACR)

21271 **(UCRL—15874) Energy-flux model of seismic coda: Separation of scattering and intrinsic attenuation.** Frankel, A.; Wennerberg, L. (Geological Survey, Menlo Park, CA (USA); Lawrence Livermore National Lab., CA (USA)). 16 Oct 1986. Contract W-7405-ENG-48. 60p. (SANL—524-004). NTIS MF A01; 2; GPO Dep. File Number DE87006244.

A new model of seismic coda is presented, based on the balance between the energy scattered from the direct wave and the energy in the seismic coda. This energy-flux model results in a simple formula for the amplitude and time decay of the seismic coda that explicitly differentiates between the scattering and intrinsic (anelastic) attenuation of the medium. This formula is valid for both weak and strong scattering and implicitly includes multiple scattering. The model is tested using synthetic seismograms produced in finite difference simulations of wave propagation through media with random spatial variations in seismic velocity. Some of the simulations also included intrinsic dissipation. The energy-flux model explains the coda decay and amplitude observed in the synthetics, for random media with a wide range of scattering Q. In contrast, the single-scattering model commonly used in the analysis of microearthquake coda does not account for the gradual coda decay observed in the simulations for media with moderate or strong scattering attenuation (scattering $Q \leq 150$). The simulations demonstrate that large differences in scattering attenuation cause only small changes in the coda decay rate, as predicted by the energy-flux model. The coda decay rate is sensitive, however, to the intrinsic Q of the medium. The ratio of the coda amplitude to the energy in the direct arrival is a measure of the scattering attenuation. Thus, analysis of the decay rate and amplitude of the coda can, in principle, produce separate estimates for the scattering and intrinsic Q values of the crust. We analyze the coda from two earthquakes near Anza, California. Intrinsic Q values determined from these seismograms using the energy-flux model are comparable to coda Q values found from the single-scattering theory. The results demonstrate that coda Q values are, at best, measures of the intrinsic attenuation of the lithosphere and are unrelated to the scatteing Q.

21272 **Laboratory-determined transport properties of Berea sandstone.** Daily, W.D.; Lin, W. (Lawrence Livermore National Lab., CA). *Geophysics;* **50**: No. 5, 775-784(May 1985). Contract W-7405-ENG-48.

The authors report laboratory measurements of electrical resistivity water permeability k, and compressional wave velocity V/sub p/ for both intact and fractured Berea sandstone samples as functions of temperature from 20 C to 200 C and effective pressure P/sub e/ from 2.5 MPa to 50 MPa. For the intact sample, V/sub p/ increases from 3.52 km/s to 4.16 km/s as P/sub e/ goes from 3 to 50 MPa. With increasing temperature, V/sub p/ decreases at rates of about 3% per 100 C at P/sub e/ of 5 MPa and about 1.5% per 100 C at P/sub e/ of 38 MPa. Data from the fractured sample are qualitatively similar, but velocities are about 10% lower. For both intact and fractured samples, p increases less than 15% as P/sub e/ increases from 2.5 MPa to 50 MPa. Although both samples show a larger decrease in resistivity with increasing temperature, most of this change is attributed to the decrease in resistivity of the pore fluid over that temperature range. For both samples, k decreases with increasing pressure and temperature. The intact sample permeability varies from 23 mD at 3 MPa and 20 C to less than 1 mD at 50 MPa and 150 C. The permeability of the fractured sample varies from 676 mD at 3 MPa and 20 C to less than 1 mD at 40 MPa and 190 C. The effect of the fracture on k vanishes after several pressure cycles and above about 100 C. These laboratory data are used to demonstrate the possibility of using resistivity and velocity measurements to estimate in-situ permeability of a reservoir. 25 references, 10 figures.

21273 **Coherent tilt signals observed in the Shumagin seismic gap: detection of time-dependent subduction at depth.** Beavan, J.; Bilham, R.; Hurst, K. (Columbia Univ., Palisades, NY). *Journal of Geophysical Research;* **89**: No. B6, 4478-4492(10 Jun 1984). Contract AC02-76ER03134.

Repeated surveys of short level lines in the Shumagin Islands, Alaska, reveal coherent tilt signals associated with subduction of the Pacific plate beneath the North American plate in the Shumagin seismic gap. Ten years of steady tilt down toward the trench is interrupted during 1978-1980 by a rapid episode of reverse tilt. The normal tilt represents surface deformation as subduction occurs with the plate boundary locked to at least 60 km depth. Using all available tilt, sea level, and seismic data, the authors interpret the tilt reversal as due to an episodic reverse slip of ca 80 cm magnitude on the plate boundary between ca 70 km and ca 20 km depth, downdip from the main seismogenic zone, which remains locked. This event causes an increase of stress on the locked main thrust zone. The authors speculate that such events may be a regular process at subduction zones, that great plate boundary earthquakes may be more common during their occurrence, and that their onset may be detectable early enough to give warning of an increase in probability for the occurrence of a great earthquake. 51 references, 10 figures, 1 table.

21274 **Patterns of earthquakes and the effect of solid earth and ocean load tides at Mount St. Helens prior to the May 18, 1980, eruption.** McNutt, S.R.; Beavan, R.J. (Columbia Univ., Palisades, NY). *Journal of Geophysical Research;* **89**: No. B5, 3075-3086(10 May 1984). Contract AC02-76ER03134.

Seismographs near Mount St. Helens Volcano recorded an earthquake swarm lasting nearly 2 months prior to the May 18, 1980, eruption. The earthquakes are divided into four classes based on station CPW ($\Delta = 116$ km) seismogram characteristics: (1) events with Sv:P amplitude ratio $> 3$ and dominant frequency $> 3$ Hz; (2) events with Sv:P ratio between 1 and 3 and dominant frequency $> 2$ Hz; (3) events similar to characteristic 2 but with a strong (probably surface wave) phase just after the S phase; and (4) events with frequencies between 1 and 2 Hz lacking a clear S phase. The seismicity pattern for each of the four classes is unique. Solid earth stress and strain tides were calculated at the average hypocentral depth of 4 km. Stress and strain tides induced by ocean loading were also calculated; their amplitudes are typically 20-40% those of the solid earth tides at the location of Mount St. Helens. A weak but significant correlation exists between the latter two classes of events and the tides for a time interval of about 5 days preceding the first onset of volcanic tremor and about 5 days thereafter. The polarity of the correlation is opposite for the two classes of events. In each case, the phase of the correlation changes systematically with time, the changes coinciding with the onset of tremor on March 31 and with a pronounced decrease in earthquake energy release rate on April 3. There are no significant correlations between the tides and the number of events or energy release of these two classes of earthquakes during any other interval between March 20 and May 18, 1980. The first two classes of events show no evidence

of significant tidal correlation at any time during the study period. 20 references, 8 figures, 2 tables.

21275 **Noise correlation lengths in remote reference magnetotellurics.** Goubau, W.M.; Maxton, P.M.; Koch, R.H.; Clarke, J. (Univ. of California, Berkeley). *Geophysics;* **49**: No. 4, 433-438(Apr 1984). Contract AC03-76SF00098.

In remote reference magnetotellurics one uses a reference magnetometer, located typically several kilometers from the magnetotelluric site, to obtain estimates of the impedance tensor that are unbiased by random noise. Measurements have been made of the correlation length of this noise by using a third SQUID magnetometer as a local reference. The impedance tensor was determined as a function of the separation between this magnetometer and the magnetotelluric site, and compared with the tensor obtained simultaneously using the remote reference. This study yielded the surprising result that a separation of as little as 200 m was sufficient to obtain an unbiased estimate of the impedance tensor. The magnitude of the magnetic noise was determined with two different techniques: one involving the impedance tensor, and the other involving a magnetic transfer tensor. The second method produced a substantially lower estimate of the magnetic noise at periods longer than about 1 sec. It is concluded that a component of the noise arises from the non-plane wave nature of the magnetic and electric fields. 4 references, 4 figures.

21276 **Magma mixing: the Marsco suite, Isle of Skye, Scotland.** Vogel, T.A.; Younker, L.W.; Wilband, J.T.; Kampmueller, E. (Michigan State Univ., East Lansing). *Contributions to Mineralogy and Petrology;* **87**: 231-241(1984).

Magma mixing has been proposed as a major mechanism for the origin of a wide variety of rock suites. In mid-ocean basalts there are few obstacles to mixing because of the similarities in chemical and physical properties of the proposed end-members. However, in calc-alkaline rocks the proposed end-members have disparate properties and these present obstacles to mixing. The Marsco suite is ideal to evaluate the process of magma mixing because it is considered to be a classic example of magma mixing of diverse magma types and because compositionally diverse, coexisting liquids were present throughout the area. The results of this study are that the chemical data for the Marsco suite fit a mixing model remarkably well and that the mixing did not take place at the present level of exposure. The Marsco mixed suite is similar to the experiments of Kouchi and Sunagawa in which mixing was produced by forced convection. Based on the Marsco suite, a similar occurrence in Ardnamurchan, and the experimental data, the authors conclude that mixing was dominated by mechanical mixing and this mechanical mixing was efficient enough to allow diffusional processes to homogenize the liquids. It is postulated that injection of mafic magma into the base of a silicic magma system leads to mixing and mobilization of the system. The mechanical interaction that produces the mixing also leads to disruption of the system. Liquids involved with the mixing process at depth are mobilized and coexist at shallower levels. 40 references, 8 figures, 2 tables.

21277 **Hydrovolcanic explosions. II. Evolution of basaltic tuff rings and tuff cones.** Wohletz, K.H.; Sheridan, M.F. (Arizona State Univ., Tempe). *American Journal of Science;* **283**: 385-413(May 1983).

Eleven basaltic volcanoes from a variety of geologic settings were studied in order to compare vent morphology, deposit stratigraphy, and emplacement mechanisms at tuff rings with those at tuff cones. The tuff rings consist of thinly bedded, poorly indurated, relatively fresh pyroclasts deposited with bedding angles less than 12. The tuff cones consist of massive, thickly bedded, high indurated, and hydrated pyroclasts deposited at bedding angles up to 30. This massive tuff contains ash-fall layers interspersed with nearly equal volumes of base-surge beds. Stratigraphic data and models of pyroclastic surge suggest that the massive bedding of tuff cones results from a cool (below 100 C), wet emplacement. In contrast, the thinly-bedded deposits of tuff rings are typically emplaced while hot (above 100 C) and relatively dry. As the volume of water that explosively mixed with magma increases, the amount of steam produced increases, but the level of superheating of that steam decreases. This leads to an increased wetness of the resulting surge blasts. With increasing ratios of water to magma, activity changes from lava fountains to dry surges to wet surges. The resulting volcanic landforms are respectively cinder cones, tuff rings, and tuff cones. Accordingly, a dry environment would contain cinder cones; abundant ground water promotes tuff rings; and a shallow body of standing water favors development of tuff cones. 48 references, 19 figures, 2 tables.

21278 **Geophysical tomography.** Daily, W.; Lytle, J. (Lawrence Livermore National Lab., CA). *Journal of Geomagnetism and Geoelectricity;* **35**: 423-442(1983). Contract W-7405-ENG-48.

A remote sensing technique has been developed for high resolution mapping of subsurface structures using ratio-wave transmissions through the ground. A transmitter and receiver are lowered in boreholes drilled on opposite sides of the underground region to be imaged. The measured attenuation and velocity of the electromagnetic waves propagated between these boreholes is determined by the electromagnetic properties of the intervening media. Maps showing the distribution of these electromagnetic properties between the boreholes can be produced by tomographic reconstruction - a technique used for several years in medical X-ray imaging. In some cases these maps can be directly related to geologic structure. This remote sensing technique has a variety of possible applications including mapping underground fracture systems; locating tunnels or water-bearing strata; mapping burn fronts during in situ coal gasification and monitoring in situ oil shale retorts. 14 references, 11 figures.

## 5803 Mineralogy, Petrology, And Rock Mechanics

*REFER ALSO TO CITATION(S) 19971, 20171*

21279 **(DOE/ER/13228—T1) Microfracturing in Westerly granite experimentally extended wet and dry at temperatures to 800°C and pressures to 200 MPa.** Hopkins, T.W. (Illinois Univ., Urbana (USA). Aeronomy Lab.; Texas A and M Univ., College Station (USA). Research Foundation). May 1986. Contract FG05-84ER13228. 79p. NTIS, PC A05/MF/A01; 1; GPO Dep. File Number DE87006337.

Microfracturing in Westerly granite specimens, extended wet and dry, at temperatures to 800°C and confining pressures to 200 MPa, is analyzed with a view toward understanding why, in the brittle field, rock strengths decrease with increasing temperature. Intragranular (IGC) and grain-boundary cracks (GBC) are mapped in two dimensions on either side of the tensile macrofracture, using optical microscopy, to determine, quantitatively, crack lengths and densities and, qualitatively, crack widths and orientations are visually examined to aid in interpretation. Temperature and confining pressure tend to favor the development of different microfracture fabrics. Thermal stresses produce a random orientation of cracks while stresses resulting from the external differential loading of a specimen produce a preferred orientation of cracks parallel to the direction of $\sigma_1$.

21280 **(DOE/ER/13322—T1) Deep burial diagenesis of carbonate reservoirs: Summary progress and present status report (through 2/14/1987).** Friedman, G.M. (Brooklyn Coll., NY (USA)). 14 Feb 1987. Contract FG02-85ER13322. 93p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87005992.

The purpose was to investigate deep burial diagenesis in carbonate rocks with emphasis on the evolution of rock textures, mineralogy, and porosity with depth. Specific investigative problems included the differential behavior of dolostones and limestones under deep burial, the role of fracture in porosity formation at depth, the relationship of experimentally induced rock compaction textures versus those in a geological situation, and the persistence of porosity under deep burial conditions. Samples for study were obtained from wells in the Anadarko Basin, and the Delaware Basin, extending to depths of 30,000 feet. Sequential samples of both dolostones and limestones were selected downhole in order to study diagenetic changes with depth. Experimental compaction tests aided in extending and duplicating information gained from geological situations.

21281 **(PB—87-128781/XAB) Clemente and Herminia Hinojosa Site, 41 JW 8: a Toyah horizon campsite in southern Texas. Special report (Final) 1980-1986.** Black, S.L.; Holloway, R.G.; Jones, J.G.; Murray, H.D.; Robinson, R.L. (Texas Univ., San Antonio (USA). Center for Archaeological Research). 1986. 313p. (SR—18). NTIS, PC A14/MF A01.

Site 41 JW 8 is a major prehistoric occupation site located along Chiltipin Creek in Jim Wells County, in southern Texas. Excavations at the site in 1981 evidenced a single component that can be linked with the Toyah horizon. Radiocarbon dating of three fire features, although not without problems, places the occupation to around A.D. 1350-1400. The excavation of 82 sq m clustered in blocks produced an abundance of well-preserved data. Special studies of faunal and botanical remains and analyses of artifacts and cultural refuse distribution provide the basis for addressing various research problems.

21282 **(UCID—20943) Compilation of mechanical properties of geological and related materials.** Kusubov, A.S.; Dockery, H.A.; Anderson, G.D. (Lawrence Livermore National Lab., CA (USA)). 28 Jan 1987. Contract W-7405-ENG-48. 51p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87005933.

This report summarizes efforts to date on compiling mechanical properties of rocks, with emphasis on NTS rocks and related materials and on rocks underlying HTK (Hard Target Kill) sites of current interest. The task had two goals: first, to provide the LLNL rock mechanics community with an interim hard copy database; and second, to outline a long-range electronic database project.

21283 **Observations of crack growth in hard rock loaded by an indenter.** Cook, N.G.W.; Hood, M.; Tsai, F. (Univ. of California, Berkeley). *International Journal of Rock Mechanics and Mining Sciences and Geomechanics Abstracts;* **21**: No. 2, 97-107(1984).

A description is given of the processes of rock fragmentation induced by circular flat-bottomed punches from 5 to 20 mm dia loading orthogonal to the flat surface of cylindrical specimens of Sierra granite of 89 mm dia and confined by a steel belt, and 100 mm cube specimens confined in a biaxial frame. It is found that the rock deforms elastically until the applied punch load exceeds 45% of the maximum load that the rock can sustain. At loads greater than 45% of the maximum, a crack is initiated around the perimeter of the punch and this crack propagates in the well-known conical Hertzian manner. When the crack begins to propagate, the location of its front is reasonably well defined. However, as it extends with continued application of the load, an intense zone of microcracks surrounds and conceals the crack tip. Fractures initiating within this microcracked region propagate to the surface and form rock chips. The effects of punch size and confining stress, orthogonal to the punch, on the rock indentation strength are examined. Some decrease in punching strength with increasing punch size is noted; there is an increase in strength with increasing confining stress. At low confining stress, specimens split by cleavage through the axis of the punch. The theory of elasticity is used to show that this could occur with a punch loading against a semi-infinite rock surface and may therefore be an important phenomenon, not just an artifact of finite laboratory specimens. 11 references, 14 figures.

21284 **Hysteresis in the closure of a nominally flat crack.** Scholz, C.H.; Hickman, S.H. (Columbia Univ., Palisades, NY). *Journal of Geophysical Research;* **88**: No. B8, 6501-6504(10 Aug 1983). Contract AC02-76ER04054.

It is shown that when two nominally flat rock surfaces are placed together and subjected to a normal load, the resulting closure closely follows a constitutive law predicted by theory. However, the constitutive law exhibits hysteresis. The hysteresis is evidently produced by friction on parts of the surface where the contact is oblique to the load. This behavior, which should be shared by joints and other fractures in the upper part of the crust, suggests that the elastic properties of the near-surface parts of the earth may be far more complex than previously thought. 11 references, 6 figures.

21285 **High temperature liquid and glass heat contents and the heats of fusion of diopside, albite, sanidine and nepheline.** Stebbins, J.F.; Carmichael, I.S.E.; Weill, D.E. (Lawrence Berkeley Lab., CA). *American Mineralogist;* **68**: 717-730(1983). Contract AC02-80ER10765;W-7405-ENG-48.

The authors have measured the relative enthalpy, H/sub T/ - H/sub 300K//sup glass/, and the heat capacities of $CaMgSi_2O_6$ (Di) stable liquid and glass; of $KAlSi_3O_8$ (Sa) stable and supercooled liquid and glass; of $NaAlSi_3O_8$ (Ab) liquid derived directly by melting solid albite; of crystalline, disordered albite itself; and of $NaAlSiO_4$ (Ne) liquid and glass. The authors have also determined the effect of annealing at 981 K on the enthalpy of the glasses quenched from liquids at high temperature. This effect is relatively small, ranging from 0 to 1100 cal/mol. Albite liquid prepared by melting of the crystalline phase has a heat capacity and relative enthalpy indistinguishable from those of a liquid produced by heating the glass. The enthalpy of crystalline, disordered albite is equal to that predicted by heat capacity data collected below 1000 K for the triclinic phase by Hemingway et al (1981). The liquid heat capacities of Ab and Sa (88.2 and 89.5 ca/mol x K) are nearly equal and are much lower than that for An liquid (113 cal/mol x K), suggesting that the latter undergoes greater structural changes, possibly depolymerization, with increasing T. The entropies of fusion of Ab and Sa (10.9 and 9.4 cal/mol x K) are similar, and much of the difference between these values and that for An (17.7 cal/mol x K) could be due to Al/Si order in crystalline An. 55 references, 4 figures, 7 tables.

## 5804 Geochemistry

*REFER ALSO TO CITATION(S) 20076*

21286 **Thermodynamic analysis of binary liquid silicates and prediction of ternary solution properties by modified quasichemical equations.** Blander, M.; Pelton, A.D. (Argonne National Lab., IL). *Geochimica et Cosmochimica Acta;* **51**: No. 1, 85-95(Jan 1987).

Modified quasichemical equations, developed for the analysis of the thermodynamic properties of structurally ordered liquid solutions, are shown to be well-suited for use with molten silicates. For binary systems, these equations have been coupled with a least-squares optimization computer program to analyze simultaneously all thermodynamic data including phase diagrams, Gibbs energies and enthalpies of formation of compounds, activities, enthalpies of mixing, entropies of fusion, miscibility gaps, etc. In this manner, data for several binary systems have been analyzed and represented with a small number of parameters. In the present article, results for the $SiO_2$-MgO, $SiO_2$-$Na_2O$ and MgO-CaO systems are presented. The resulting equations represent all the binary data, including the phase diagrams, within or virtually within experimental error limits. From the modified quasichemical equations for ternary systems, ternary thermodynamic properties can be approximated solely from data from the subsidiary binary systems. Results for the $SiO_2$-CaO-$Na_2O$, $SiO_2$-CaO-MgO, and $SiO_2$-MgO-FeO systems are in excellent agreement with measured ternary data. Predictions for the quaternary system $SiO_2$-MgO-CaO-$Na_2O$ are also presented.

21287 **Prediction of borate mineral equilibria in natural waters: application to Searles Lake, California.** Felmy, A.R.; Weare, J.H. (Univ. of California, San Diego). *Geochimica et Cosmochimica Acta;* **50**: No. 12, 2771-2783(Dec 1986). Contract AC03-85SF15522.

A chemical equilibrium model has been extended to include borate species. The model is based upon the semi-empirical equations and is valid to high ionic strength ($\approx$ 14 m) and high borate concentration. Excellent agreement with the existing emf, isopiestic, and solubility data in the system (Na-K-Ca-Mg-H-Cl-$SO_4$-$CO_3$-$B(OH)_4$-$H_2O$) is obtained. Calculated mineral solubilities are in general within 10% of their experimental values, even at high ionic strengths. The model was applied to the multicomponent, high ionic strength (I $\sim$ 10) and high borate concentration (B/sub T/ $\sim$ 0.5 m) Searles Lake evaporite deposit. Utilizing the chemical composition of the interstitial brine the model predicts equilibrium between the brine and only those minerals which are known to be in contact with the brine. These calculations clearly demonstrate the

applicability of the model to high ionic strength, high borate concentration natural waters. The model was also utilized to calculate the mineral sequences which should result from evaporation of the major source of water for Searles Lake, the Owens River. The geochemical conditions necessary for the formation of the most recent mud and saline units are examined. The final results indicate that the mineral sequences found in the most recent saline unit in Searles Lake can be produced by evaporation of a water close in composition to present Owens River water, provided primary dolomite formation is delayed and back reaction between the Parting Mud and the Upper Salt is inhibited.

21288 **Ferric-ferrous ratio of natural silicate liquids equilibrated in air.** Kilinc, A.; Carmichael, I.S.E.; Rivers, M.L.; Sack, R.O. (Univ. of California, Berkeley). *Contributions to Mineralogy and Petrology;* **83**: 136-140(1983). Contract W-7405-ENG-48.

Results of chemical analyses of glasses produced in 46 melting experiments in air at 1350 C and 1450 C on rocks ranging in composition from nephelinite to rhyolite have been combined with other published data to obtain an empirical equation relating ln (X/ sub $Fe_2O_3$//sup liq//X/sub FeO//sup liq/) to T, lnf/sub $O_2$/ and bulk composition. The whole set of experimental data range over 1200-1450 C and oxygen fugacities of 10/sup -9.00/ to 10/sup -0.69/ bars, respectively. The standard errors of temperature and $\log_{10}$f/sub $O_2$/ predictions from this equation are 52 C and 0.5 units, respectively, for 186 experiments. 7 references, 1 figure, 5 tables.

## 5805 Oceanography

*REFER ALSO TO CITATION(S) 21127*

21289 **(DOE/ER/60355—1) Circulation and exchange processes on the South Atlantic Bight: Progress report, June 1, 1986 to May 31, 1987.** Lee, T.N. (Miami Univ., FL (USA). Div. of Meteorology and Physical Oceanography). Jan 1987. Contract FG05-85ER60355. 48p. NTIS, PC A03/ MF A01; 1; GPO Dep. File Number DE87005307.

A SPring Removal EXperiment (SPREX) was devised to investigate the processes involved in the transport of fresh water from the inner-shelf in the vicinity of Savannah GA where river discharge is greatest, to the outer shelf south of Cape Fear, SC, where rapid exchange with the offshore current can occur. The SPREX experiment was conducted in the spring of 1985, however prior to this we conducted a pilot experiment called pre-SPREX during the spring of 1984. The studies took place in the spring in order to investigate the processes associated with the offshore transport of low salinity nearshore waters to the oceanic sink that is believed to occur during this season. Available evidence indicates that this spring removal process occurs as an episodic response to: (1) accumulation of river run-off in the Coastal Boundary zone, (2) northeastward wind events, and (3) seasonal development of shelf stratification. During the period from June 1, 1986 to May 31, 1987, efforts were concentrated on: (1) publication of scientific results from the GABEX studies; (2) processing and analysis of the pre-SPREX and SPREX data sets; (3) cooperative studies with other DOE/SAB investigators; and (4) planning for the Fall Transport Experiment (FLEX).

# 64 PHYSICS I

21290 **(FRCEA-R—23) Institute of Fundamental Research: forty years of research.** (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). 1986. 188p. (In French). NTIS (US Sales Only), PC A09/MF A01. File Number DE87751056.

This document is aimed at illustration of forty years of fundamental research at CEA. It has not been conceived to give an exhaustive view of current research at IRF, but to give an illustration of these researches to non-specialists, and even to non-scientifists.

## 6401 Astrophysics And Cosmology

*REFER ALSO TO CITATION(S) 20976, 21042, 21418, 21487, 21487, 21603, 21795, 21796*

21291 **(AD-A—175356/5/XAB) Petersen multipliers for several SEU (Single Event Upset) environment models. Technical report.** Chenette, D.L. (Aerospace Corp., El Segundo, CA (USA). Space Sciences Lab.). 30 Sep 1986. 35p. (TR—0086(6940-05)-6). NTIS, PC A03/MF A01.

Several published models for the interplanetary heavy-ion environment resulting from galactic cosmic rays and solar-flare-accelerated ions are described. These models are used to calculate linear energy transfer (LET) spectra behind 1 $cm^{-2}$ (150 mils) of aluminum shielding. Appropriate parameters (multipliers) are deduced form these spectra for use in the suggested Single-Event Upset figure-of-merit calculation described by Petersen et al. (1983). The results of this study are compared to the suggestions of E.C. Smith, and the differences between the two are discussed.

21292 **(CONF-860720—2) Bounds on galactic cold dark matter particle candidates and solar axions from a Ge-spectrometer.** Gelmini, G. (Harvard Univ., Cambridge, MA (USA). Lyman Lab. of Physics; Chicago Univ., IL (USA). Enrico Fermi Inst.). Nov 1986. Contract AC02-82ER40073. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87004575.

From Quarks and galaxies: theoretical workshop on cosmology and particle physics; Berkeley, CA, USA (28 Jul 1986).

The ultralow background Ge spectrometer developed by the USC/PNL group is used as a detector of cold dark matter candidates from the halo of our galaxy and of solar axions (and other light bosons), yielding interesting bounds. Some of them are: heavy standard Dirac neutrinos with mass 20 GeV $\leqq$ m $\leqq$ 1 TeV are excluded as main components of the halo of our galaxy; Dine-Fischler-Srednicki axion models with F/2x/sub e/' $\leqq$ 0.5 x $10^7$ GeV are excluded. 22 refs., 7 figs.

21293 **(EFI—783(10)-85) Topological aspects of the birth of the Universe.** (Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike, Moscow (USSR)). 1985. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700861.

It is noted that in Hartly-Hawking's approach to the calculation of the Universe birth amplitude there are topological restrictions on the properties of born Universe and matter fields in it. These restrictions are obtained in explicit form in particular cases. The possible consequence is the statement that the baryon charge of our Universe would be zero in the absence of the baryon number nonconserving interactions. 8 refs.

21294 **(EFI—791(18)-85) ANI experiment: problems and the realization status.** (Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike, Moscow (USSR)). 1985. 24p. (In Russian). (CONF-8501107—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700862.

From Scientific council AN Arm. SSR on nuclear energetic and technology; Yerevan, USSR (15 Jan 1985).

The main problems of ANI experiment (hadron ground research) are described. Physical ground of the experiment, ANI structure and composition, the state of object construction are presented. The main experimental problems are: study of hadrons and cosmic radiation nuclei in the energy range from 10/sup 3/ to 10/ sup 5/ TeV, exotic phenomena and particle search, study of spectrum, chemical composition and cosmic ray variations. 2 refs.; 8 figs.

21295 **(INIS-BR—576) Cosmic gamma radiation of ultra high energy of primordial origin.** (Centro Tecnico Aeroespacial, Sao Jose dos Campos (Brazil). Inst. Tecnologico de Aeronautica). 1984. 70p. (In Portuguese). NTIS (US Sales Only), PC A04/MF A01. File Number DE87700924.

The quantum mechanical effects near a collapsing black hole as shown by Stephen W. Hawking in 1974 to produce streaming particles through tunneling effect was explored in the context of cosmic gamma ray production. In this thesis, we show the possible production of gamma rays of high energies ($\nu$ approx 10/sup 41/ Hz) in the initial stages of the formation of the Universe by the explosion of primordial mini black holes. These mini black hole explosions happening at 10/sup -43/ s to 10/sup -37/ s after the start perhaps may account for the existing universal cosmic background radiation of 2.7/sup 0/K.

21296 **(INIS-SU—398) Problems of nuclear physics and cosmic rays. No. 23. Republican Interinstitute scientific technical collection.** (Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya Ukrainskoj SSR, Kiev; Khar'kovskij Gosudarstvennyj Univ. (Ukrainian SSR)). 1985. 98p. (In Russian). NTIS (US Sales Only), PC A05/MF A01. File Number DE87780090.

Individual papers in this collection are abstracted separately. (LEW)

21297 (INIS-SU—399, pp 34-36) **On the magnetohydrodynamic wave absorption in the solar corona.** Chashej, I.V. 1986. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87780091.

Kratkie Soobshcheniya po Fizike. No. 4.

In Experimental and theoretical data. Collection.

The process of absorption of Alfven and slow magnetoacoustic waves in the solar corona is studied. It is shown that a heat source arising in dissipation of magnetohydrodynamic waves in the solar corona has its maximum in the region, where wave energy-containing frequency ($\omega$sub(0) approximately 2 x 10/sup -2/S/sup -1/) is close to that of ion-ion collisions. As it follows from integral absorption coefficients, the Alfven waves with $\omega < \omega$sub(0) may leave the corona. 8 refs.

21298 **(LA-UR—87-285) Detailed MSW calculations for solar $^8$B neutrinos: Probabilities for electron neutrinos to remain electron neutrinos at earth as a function of energy, DELTA m$^2$, and sin/sup 2/2theta.** Rosen, S.P.; Gelb, J.M. (Los Alamos National Lab., NM (USA)). Jan 1987. Contract W-7405-ENG-36. 26p. (CONF-870483—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006075.

From Santa Barbara workshop on solar neutrinos; Santa Barbara, CA, USA (29 Apr 1987).

The results of detailed two-flavor MSW calculations are presented for solar $^8$B neutrinos. The probabilities for solar neutrinos to remain electron neutrinos at earth are calculated as functions of energy, $\Delta m^2$, and $\sin^2 2\theta$, and the results are presented in both graphical form and numerical form. The numerical results are contained on an IBM PC compatible floppy diskette which also contains the $^8$B spectrum. Thus all of the data can be combined to predict results for any detector scheme. 4 refs., 28 figs.

21299 **(LA-UR—87-358) A third class of high energy burster.** Laros, J.G.; Fenimore, E.E.; Klebesadel, R.W. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 4p. (CONF-861264—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87006051.

From Texas symposium; Chicago, IL, USA (14 Dec 1986).

Until recently, only two cosmic high-energy burster classes - x-ray bursters and gamma-ray bursters (GRBs) - were recognized. However, as early as 1979 it was realized that events similar to GRBs, but which did not fit comfortably into that class, occasionally occurred. This realization arrived in the form of the famous "March 5 Event" of 1979, which had, among its many unique attributes, typical photon energies of tens of keV - that is, midway between x-ray burster and GRB energies. Subsequently, the source was seen to repeat sporadically about a dozen times, with about one day separating the closest recurrences. Eventually, a few other bursters unlike normal GRBs and possibly related to the March 5 source were found. All had similar average photon energies of tens of keV, and most had durations of tenths of a second. One of them, first seen on March 24, 1979, repeated twice within three days. Unfortunately, this suspected third class of high-energy burster may be one of the least well studied phenomena in astrophysics. This is largely because most of the photons are emitted at "awkward" energies, in the gap between the regions of coverage provided respectively by most of the x-ray and gamma-ray instrumentation in space. 3 refs., 1 fig.

21300 **(LA-UR—87-409) Detection of $10^{14}$-eV gamma rays from Cygnus X-3 during 1986.** Nagle, D.E.; Bolton, R.D.; Burman, R.L.; Butterfield, K.B.; Cady, R.; Carlini, R.D.; Sandberg, V.D.; Williams, R.A.; Wilkinson, C.; Chang, C.Y. (Los Alamos National Lab., NM (USA); Maryland Univ., College Park (USA); Tata Inst. of Fundamental Research, Bombay (India); George Mason Univ., Fairfax, VA (USA); New Mexico Univ., Albuquerque (USA); California Univ., Irvine (USA)). Jan 1987. Contract W-7405-ENG-36. 6p. (CONF-870157—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006054.

From Relativistic astrophysics conference; Pasadena, CA, USA (4 Jan 1987).

Cosmic ray muons associated with extensive air showers were detected by a scintillator array. Data were collected within a 30 degree cone centered about the zenith. About 20,000 showers per day were recorded. 5 refs., 4 figs.

21301 **(N—87-14148) White paper on dusty plasmas.** Whipple, E.C. (California Univ., San Diego, La Jolla (USA)). Apr 1986. 22p. (NASA-CR—179974; NAS—1.26:179974; CONF-8602114—1). NTIS, PC A02/MF A01.

From Workshop on dusty plasmas; San Diego, CA, USA (10 Feb 1986).

Dusty plasmas is the name given to plasmas heavily laden with charged dust grains which together with the surrounding ions and electrons constitute a kind of plasma regime. This field of study is receiving increased attention because of the observation of dust during recent spacecraft missions to the planets and comets, together with the dawning recognition that the evolution of dusty plasma clouds in space may be quite different from that of nondusty clouds. Recent work in this field is reviewed and recommendations are made on the kind of research that is needed in the immediate future.

21302 **(N—87-15043) Summer school on interstellar processes: Abstracts of contributed papers.** Hollenbach, D.J.; Thronson, H.A. Jr. (National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center). Oct 1986. 205p. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.). NTIS, PC A10/MF A01.

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

The Summer School on Interstellar Processes was held to discuss the current understanding of the interstellar medium and to analyze the basic physical processes underlying interstellar phenomena. Extended abstracts of the contributed papers given at the meeting are presented. Many of the papers concerned the local structure and kinematics of the interstellar medium and focused on such objects as star formation regions, molecular clouds, HII regions, reflection nebulae, planetary nebulae, supernova remnants, and shock waves. Other papers studied the galactic-scale structure of the interstellar medium either in the Milky Way or other galaxies. Some emphasis was given to observations of interstellar grains and

21303 (N—87-15043, pp vp) **MM and subMM molecular line observations of the southwest lobe of L1551: evidence of a shell structure.** Rainey, R.; White, G.J.; Richardson, K.J.; Griffin, M.J.; Cronin, J.; Hilton, J.; Monteiro, T.S. (Bath Univ., England; Newcastle-upon-Tyne Univ., England). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Observations have been made of the southwest outflow lobe of L1551 in several millimeter and submillimeter molecular lines. Maps have been made in the J=3-2 and J=2-1 transitions of CO over areas of 7.5 by 2.5 arc minutes and 5 by 5 arc minutes respectively at UKIRT. More detailed maps have also been made in the J=2-1 CO transition over an area of about 6 by 3.5 arc minutes at

the NRAO 12m telescope. Additional observations of the J=4-3 transitions of HCN, HCO(+) abd H(13)CO(+) were made at selected positions. The HC(+) J=4-3 transition was detected at several positions along the outflow axis and at the position of IRS 5. Similarly the HCN J=4-3 transition was detected at the position of IRS 5 and also at a position close to HH29. However, the J=4-3 transition of H(13)CO(+) was bit detected at the position of IRS 5 even through it was observed at the position close to HH29 with a peak corrected antenna temperature of 0.23K at a V(LSR) of 1 km s(-1). The detection of the J=4-3 transitions of both HCO(+) and H(13)CO(+) close to the position of HH29 suggest the presence of very dense gas in this region. LVG analysis of the various molecular lines observed give a kinetic temperature between 10 and 15K and a density from 10(5) to 10(6) cm(-3) at the position of IRS 5 at the ambient cloud velocity. At the position close to HH29 LVG analysis of the CO observations gives a density between 10(3) and 10(4) cm(-3) at a kinetic temperature of 25k for a V(LSR) of 0 km s(-1). To the southwest of HH29 there is a large decrease in both the linewidth and intensity of CO emission. This may be due to the interaction between the outflow and a dense clump of gas which gives rise to HH29. The maps of the CO J=3-2 and CO J=2-1 emission integrated in 3.25 km s intervals show the shell structure postulated by Snell and Schloerb (1985).

21304 (N—87-15043, pp vp) **High resolution observations of the L1551 bipolar outflow.** Snell, R.; Moriarty-Schieven, G.; Strom, S.; Schloerb, P.; Strom, K.; Grasdalen, G. (Wyoming Univ., Laramie). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Optical and radio continuum observations show the presence of a highly collimated, ionized stellar wind orginating from close to IRS-5 and aligned with the molecular outflow. However, we have little information on the actual mechanism that generates the stellar wind and collimates it into opposed jets. The Very Large Array (VLA) observations indicate that the winds originate within 10(15) cm of IRS-5, unfortunately at a size scale difficult to resolve. For these reasons, observations of the structure and dynamics of the hypersonic molecular gas may provide valuable information on the origin and evolution of these outflows. In addition, the study of the impact of the outflowing gas on the surrounding molecular material is essential to understand the consequence these outflows have on the evolution and star formation history of the entire cloud. Moriarty-Schieven et al. (1986) obtained a oversampled map of the CO emission of a portion of both the blueshifted and redshifted outflows in LI551 using Five College Radio Astronomy Observatory 14 m telescope. The oversampled maps have been reconstructed to an effective angular resolution of 20 arcsec using a maximum entropy algorithm. A continuation of the study of Moriarty-Schieven et al. is presented. The entire L1551 outflow has now been mapped at 12 arcsec sampling requiring roughly 4000 spectra. This new data has shown that the blueshifted lobe is more extended than previously thought and has expanded downstream sufficiently to break out of the dense molecular cloud, but the redshifted outflow is still confined within the molecular cloud. Details of the structure and kinematics of the high velocity gas are used to test the various models of the origin and evolution of outflows.

21305 (N—87-15043, pp vp) **Compact density condensation around L1551-IRS 5: 2.7mm continuum observations with 4″ resolution.** Keene, J.; Masson, C. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

The dark cloud L1551 contains the best known examples of bipolar molecular outflow. Such outflows are assumed to be driven by winds from young stars embedded in a cloud but the mechanism for collimation of the outflows is still in doubt, though it has been much debated. Among the possibilities put forth to date are intrinsically anisotropic stellar winds, isotropic stellar winds collimated by interstellar toroidal shaped clouds on the order of 10(17) cm in size, or circumstellar disks of order 10(15) cm in size. Because the outflow in L1551 as revealed by the Very Large Array (VLA) cm continuum observations is collimated even at the arc second level it seems as though the stellar wind powering the outflow must either be initially anisotropic or be collimated by something very close to the star, such as a circumstellar disk. We have observed L1551 in the continuum at 2.7 mm with the OVRO millimeter-wave interferometer in the winter of 1983-4 and again, more extensively, in 1985-6. The resulting map shows for the first time direct evidence for a density condensation capable of collimating an initially isotropic flow from IRS 5. This map made from data taken in 1985-6 with projected baselines up to 100 m in length (37k lambda). It has been cleaned and reconstructed with a 4″ gaussian beam. It shows a nearly unresolved source with a suggestion of extension at the 3″ level (assuming a gaussian source shape). The integrated flux density in this map is 170 mJy. A composite spectrum of L1551 is presented which shows that the flux at 2.7 mm is due to the thermal radiation from dust that is also seen at shorter wavelengths. Very little of it can be due to the continuation of the nearly flat cm wavelength spectrum which is assumed to be from thermal bremsstrahlung radiation. The map and spectrum provide strong constraints on the size, temperature, and optical depth of the density condensation surrounding IRS 5.

21306 (N—87-15043, pp vp) **Image restoration and superresolution as probes of small scale far-IR structure in star forming regions.** Lester, D.F.; Harvey, P.M.; Joy, M.; Ellis, H.B., Jr. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Far-infrared continuum studies from the Kuiper Airborne Observatory are described that are designed to fully exploit the small-scale spatial information that this facility can provide. This work gives the clearest picture to date on the structure of galactic and extragalactic star forming regions in the far infrared. Work is presently being done with slit scans taken simultaneously at 50 and 100 microns, yielding one-dimensional data. Scans of sources in different directions have been used to get certain information on two dimensional structure. Planned work with linear arrays will allow us to generalize our techniques to two dimensional image restoration. For faint sources, spatial information at the diffraction limit of the telescope is obtained, while for brighter sources, nonlinear deconvolution techniques have allowed us to improve over the diffraction limit by as much as a factor of four. Information on the details of the color temperature distribution is derived as well. This is made possible by the accuracy with which the instrumental point-source profile (PSP) is determined at both wavelengths. While these two PSPs are different, data at different wavelengths can be compared by proper spatial filtering. Considerable effort has been devoted to implementing deconvolution algorithms. Nonlinear deconvolution methods offer the potential of superresolution -- that is, inference of power at spatial frequencies that exceed D lambda. This potential is made possible by the implicit assumption by the algorithm of positivity of the deconvolved data, a universally justifiable constraint for photon processes. We have tested two nonlinear deconvolution algorithms on our data; the Richardson-Lucy (R-L) method and the Maximum Entropy Method (MEM). The limits of image deconvolution techniques for achieving spatial resolution are addressed.

21307 (N—87-15043, pp vp) **Modeling of infrared flux spectra from disk-shaped interstellar dust clouds.** Spagna, G.F., Jr.; Leung, C.M. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Recently we generalized the quasi-diffusion method developed by Leung (1975, 1976) for spherical geometry to solve the problem of scattering, absorption, and reemission by dust grains in a medium of disk geometry. Using this technique and realistic grain opacities we construct theoretical models to determine self-consistently the dust temperature distribution and infrared emission from disk-shaped, quiescent dark globules heated externally by the interstellar radiation field. The effects of the following parameters on the temperature structure and the emergent spectrum are studied: grain type (graphite and silicate), optical depth, density inhomogen-

city, and degree of disk flattening. The disk models are characterized by an aspect ratio and an optical depth at 0.55 microns. For inhomogeneous models, a gaussian density distribution is assumed such that the ratio of central to surface density is 100. To study the effects of source geometry, we also compare results for models with spherical and disk geometry. In this case both models have the same radius and central optical depth, the disk models having a 1:1 aspect ratio. While the dust temperature distributions in the two cases are very similar, the emergent flux for the disk model depends sensitively on the viewing angle. For clouds which are unresolved, one would expect, since the thermal emission is isotropic in the neighborhood of an emitting grain, and since the emission (in the far infrared) is optically thin, that the emergent flux spectrum should be characteristic only of the dust temperature, and independent of viewing angle. However, because of the lack of complete symmetry and the resulting radiation anisotropy, this is found not to be the case for the disk models. Angle is that it implies a large uncertainty in estimating the radiation dust mass.

21308 (N—87-15043, pp vp) **Models of polarized infrared emission from bipolar nebulae.** Burns, M.S.; Johnson, P.; Thronson, H.A., Jr. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Many stars with circumstellar dust shells show a high degree of linear polarization (Sato et al. 1985). We are developing a model which assumes that the polarization arises from scattering by circumstellar dust. Our model assumes a geometry in which the star is surrounded by an optically thin spherical dust shell and embedded within an optically thick disk. This geometry is consistent with that proposed for objects with bipolar molecular outflow. This is important because many bipolar flow objects have also been observed to be highly polarized. The high degree of linear polarization is produced because the disk differentially attenuates the light from the star. The light incident from the point source is attenuated by a factor of exp(-tau/cos theta) where theta is the angle between a ray from the point source to the scatterer and a ray normal to the disk; tau is the optical depth at the wavelength of interest. Hence, the light scattered from the regions directly above and below the disk give the largest contribution to the total flux. The scattering angle for light from these regions is near 90 deg., so the light is strongly polarized and, in the Rayleigh scattering regime, is polarized parallel to the disk. The Stokes parameters for the scattered light from each particle in the shell are calculated by using the scattering matrix elements generated by a Mie scattering program. After the Stokes parameters for each particle are computed they are summed to give the Stokes parameters for the entire shell. Two graphs are presented which show the intensity and polarization spectrum generated by our model using the optical constants for astronomical silicates as defined by Draine and Lee (1984).

21309 (N—87-15043, pp vp) **Young stars always associated with cold massive disks? A CO and millimeter interferometric continuum survey.** Mundy, L.G.; Wilking, B.A.; Myers, S.; Howe, J.E.; Blackwell, J.H.; Likkel, L. (Missouri Univ., St. Louis; Texas Univ., Austin; California Univ., Los Angeles). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

The results of a combined millimeter-spectral-line and continuum survey of cold far-infrared sources selected to favor embedded young stars in the Galaxy are presented. The spectral-line observations were performed with the 5 meter antenna of the University of Texas Millimeter-Wave Observatory. High resolution continuum observations were obtained with the Owens Valley (OVRO) Millimeter-Wave Interferometer. The goal of the survey was to gain insight into the mass, temperature, and distribution of cold dust which envelopes stars during the earliest stages of their evolution. The first phase of our survey involved 1.2 arcmin resolution observations of CO-12 and CO-13 emission lines toward each source. All but two sources had detectable CO emission. We found that 40% of the sources appear to be associated with star formation as evidenced by the presence of enhanced CO-12 line widths or broad wings. At least five of these objects are associated with bipolar molecular outflows. The second phase of our survey involves high resolution 2.7 mm continuum observations with 3 interferometer baselines ranging from 15 to 55 m in length. Preliminary results indicate that about 25% of the sources in our sample have detectable continuum emission. The high percentage of sources with enhanced CO-12 line widths or broad wings indicates that a significant fraction of our samples, 40%, are likely to be young stars. The lower detection percentage in the continuum observations, 25%, suggest that such objects are not always surrounded by large concentrations of gas and dust. The continuum detection percentage for actual dust emission could be lower than that given above since emission from ionized gas could be responsible for the observed 2.7 mm emission in some objects. To get an understand the type of object detected, a map of one of the survey sources, L1689N, has been made.

21310 (N—87-15043, pp vp) **Asymmetric profile of the H76 alpha line emission from MWC349.** Rodriquez, L.F.; Canto, J.; Escalante, V.; Moran, J.M. (Harvard-Smithsonian Center for Astrophysics, Cambridge, MA). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

MWC349 is an emission-line star found by Merrill, Humason and Burwell (1932). Braes, Habing and Schoenmaker (1972) discovered that it is a strong radio source. The radio emission originates in a massive ionized wind that is expanding with a velocity of about 50 km s(-1). Its continuum spectrum fits well a nu(0.6) power law from the cm wavelengths to the far-IR. Radio recombination line emission from the envelope of MWC349 was first detected by Altenhoff, Strittmatter and Wendker (1981). We have obtained good signal-to-noise ratio, Very Large Array observations of the H76 alpha radio recombination line from the ionized wind of MWC349. Our data reveal that the profile is markedly asymmetric, with a steep rise on the blue side. This asymmetry could be due to non-LTE effects in the formation and transfer of the line or to intrinsic asymmetries in the envelope. Our analysis suggests that most probably the peculiar profile is caused by a non-LTE enhancement of the line emission from the side of the envelope nearer to the observer. This asymmetry has the opposite sense than that observed in optical and IR recombination lines, where a different effect (absorption of the stellar continuum by the gas in the wind between the star and the observer) is known to be dominant, leading to the classic P Cygni profile. We propose that the profiles of the radio recombination lines from ionized stellar winds will have this characteristic shape, while optical and IR recombination lines are characterized by P Cygni-like profiles. Unfortunately, at present the detection of radio recombination lines from ionized stellar winds is only feasible for MWC349 and a few other objects.

21311 (N—87-15043, pp vp) **$C_3H_2$ observations as a diagnostic probe for molecular clouds.** Avery, L.W. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Recently the three-membered ring molecule, cyclopropenylidene, $C_3H_2$, has been identified in the laboratory and detected in molecular clouds by Thaddeus, Vrtilek and Gottlieb (1985). This molecule is wide-spread throughout the Galaxy and has been detected in 25 separate sources including cold dust clouds, circumstellar envelopes, HII regions, and the spiral arms observed against the Cas supernova remnant. In order to evaluate the potential of $C_3H_2$ as a diagnostic probe for molecular clouds, and to attempt to identify the most useful transitions, statistical equilibrium calculations were carried out for the lowest 24 levels of the ortho species and the lowest 10 levels of the para species. Many of the sources observed by Matthews and Irvine (1985) show evidence of being optically thick in the 1(10)-1(01) line. Consequently, the effects of radiative trapping should be incorporated into the equilibrium calculations. This was done using the Large Velocity Gradient approximation for a spherical cloud of uniform density. Some results of the calculations for T(K)=10K are given. Figures are presented which show contours of the logarithm of the ratio of peak line brightness

temperatures for ortho-para pairs of lines at similar frequencies. It appears that the widespread nature of $C_3H_2$, the relatively large strength of its spectral lines, and their sensitivity to density and molecular abundance combine to make this a useful molecule for probing physical conditions in molecular clouds. The 1(10)-1(01) and 2(20)-2(11) K-band lines may be especially useful in this regard because of the ease with which they are observed and their unusual density-dependent emission/absorption properties.

21312 (N—87-15043, pp vp) **43GHz VLBI mapping of SiO maser emission associated with Orion-KL IRC-2.** Greenhill, L.J.; Moran, J.M. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

A milliarcsecond resolution spot map of the SiO maser emission associated with IRC-2 in Orion-KL is presented. The two dominant groups of spectral features, near V(LRS) = -6 and 16 km/s, were observed in the 43 GHz, v = 1 to 0 transition of SiO, using a Mark III VLBI system. The 74 km baseline ran from Haystack Observatory in Westford, Massachusetts to Five College Radio Astronomy Observatory (FCRAO) in New Salem, Massachusetts. Five distinct maser features were observed: -8.5 to -6.5 km/s; -5 to -1.5 km/s; 12 to 13.5 km/s; 16.5 to 19 km/s; and 20 to 21 km/s (stellar velocity = 5 km/s). The relative positions were established, from an analysis of fringe phases, to an accuracy of about 5 milliarcseconds. All the features lay within an area of radius 0.08 arcseconds or 6x10(14) cm, at a distance of 500 pc. Previous interferometric studies were only able to measure the gross separation between the red and the blue shifted groups. Our measurement of the separation between these two gropus is consistent with those of the previous studies, indicating the persistence of these two centers of activity. The absolute positions of the masers with respect to IRC-2 are only known to an accuracy of about 1 arcsecond. It is assumed that IRC-2 is centered between the red shifted and the blue shifted maser features. The relative placement of these two groups of maser features agrees with observations of thermal emission from SiO, which traces the outflow on a much larger scale. The SiO masers trace the neutral outflow from IRC-2 on the smallest scale yet observed.

21313 (N—87-15043, pp vp) **Pervasive small-scale structure in molecular clouds.** Martin, B.; Lada, E. (Texas Univ., Austin). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

An unbiased CO survey of molecular cloud cores was completed, and the profiles were analyzed within the context of a model for emission from clumpy clouds. It was found that all sources observed contain a significant amount of structure that is not resolved with our 2.3-arcmin beam, and that the parameters which describe the degree of clumping span a remarkably narrow range of the possible values. We studied two separate samples of cloud cores: a large sample of warm cores from the Massachusetts-Stony Brook $^{13}CO$ survey of the first galactic quadrant, and a sample of cool cores in the Taurus dark clouds chosen primarily on the basis of $H_2CO$ emission. We observed all sources in the 1-0 transition of $^{12}CO$ and $^{13}CO$ with the 5-m telescope of the Millimeter Wave Observatory. The $^{12}CO/^{13}CO$ ratios can be explained if there is unresolved structure giving rise to significant variations of opacity across the beam. Our model cloud consists of a large number of identical clumps distributed randomly in the beam. These clumps have velocity widths v small compared to the width of the observed profile, which is determined by the relative motion of the clumps. The entire cloud is isothermal and in local thermodynamic equilibrium. With these assumptions the intensity and linewidth ratios depend on three parameters: the abundance ratio; the peak $^{13}CO$ opacity through a single clump, tau(0); and the average number of clumps on a line of sight N. Small tau(0) and large N correspond to the microturbulent limit, which is indistinguishable from a uniform gas distribution. In the other extreme, large tau(0) and small N, at a given velocity at most one clump contributes to the profile on each line of sight. A figure is presented which shows the model parameters which reproduce the measured intensity and linewidth ratios for the sample of warm cores, assuming an abundance ratio of 75.

21314 (N—87-15043, pp vp) **$HC_3N$ maps of OMC1.** Masson, C.R.; Mundy, L.G. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

We have made 3.8 sec resolution maps of $HC_3N$ (J = 12-11) and 2.7 mm continuum emission in OMC1 using the OVRO mm interferometer. The continuum map, which traces dust column density, shows that the hot core region consists of several clumps, the densest of which lies 3 sec SE of IRc2. $HC_3N$, which traces dense gas, shows the velocity structure in the region. There is no simple pattern of rotation or expansion, nor does the emission resemble a disk centered on IRc2. Since the velocity difference between the hot core and IRc2 and the velocity dispersion in the hot core are comparable with the orbital velocity at a distance of 3 sec. from a 20 M(solar) object, it is possible that the hot core material is bound to IRc2. In the channel at 10.4 km s(-1) V(LSR), we detect strong emission from the source 20 sec NE of IRc2, which confirms indications from continuum and CS (J = 2-1) maps that this is a very dense, possibly protostellar, object. This emission is clearly resolved from the hot core and is elongated north-south, along the direction of the ridge emission. An additional interesting feature in these maps is a compact high velocity source located 4 sec SW of IRc2. This source has a velocity dispersion greather than 20 km/s (FWHM) and is spatially coincident with the zero-offset source seen by Pauls et al. (1983) and a point source in the near IR images taken by Allen et al. (1984). The large localized velocity, dispersion and the highly obscured IR source suggest that this compact source is an outflow from a young stellar companion to IRc2.

21315 (N—87-15043, pp vp) **CO mapping of the Orion molecular cloud: the influence of star formation on cloud structure.** Schloerb, F.P.; Snell, R.L.; Goldsmith, P.F.; Morgan, J.A. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Regions of massive star formation have long been believed to have a profound influence on the structure of their surrounding molecular clouds. The ways in which massive star formation has altered the structure and kinematics of the Orion Molecular Cloud are discussed. The data to be discussed consists of a large scale map of the CO J=1-0 emission from approximately 3 square degrees of OMC-1. During 1985, the Five College Radio Astronomy Observatory 14M antenna was used to map a 2 deg x 1 deg region centered on alpha(1950) = 5(h)33(m)00(s) delta(1950) = -5 deg 30 min. The region mapped in 1985 covers the well known HII regions M42, M43, and NGC1977, and the CO map contains abundant evidence of the interaction between these regions and the molecular cloud. Indeed, the global structure of the cloud appears to have been strongly influenced by the continuous formation of massive stars within the cloud. Individual instances of some of these features are discussed. There appear to be two classes of features which are indicative of this interaction: CO bright rims and CO holes. During 1986, we have undertaken further mapping of OMC-1 to the south of the region covered by the 1985 map. This portion of the cloud contains significant regions of star formation, but O star formation has not occured and large HII regions have not developed to alter the appearance of the cloud. A detailed map of this region is thus an opportunity to view the structure of the molecular cloud before it has been altered by massive star formation. Preliminary analysis of data obtained in this region suggests that the structure and kinematics of the southern portion of the Orion cloud are indeed dramatically different from those of the region previously mapped. Comparison of the two regions thus supports models of the development of structure in molecular clouds through interaction with the HII regions formed within them.

21316 (N—87-15043, pp vp) **Filamentary structure in the Orion molecular cloud.** Bally, J.; Dragovan, M.; Langer, W.D.; Stark, A.A.; Wilson, R.W. (Princeton Univ., NJ). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

A large scale $^{13}CO$ map (containing 33,000 spectra) of the giant molecular cloud located in the southern part of Orion is presented which contains the Orion Nebula, NGC1977, and the LI641 dark cloud complex. The overall structure of the cloud is filamentary, with individual features having a length up to 40 times their width. This morphology may result from the effects of star formation in the region or embedded magnetic fields in the cloud. We suggest a simple picture for the evolution of the Orion-A cloud and the formation of the major filament. A rotating proto-cloud (counter rotating with respect to the galaxy) contians a b-field aligned with the galaxtic plane. The northern protion of this cloud collapsed first, perhaps triggered by the pressure of the Ori I OB association. The magnetic field combined with the anisotropic pressure produced by the OB-association breaks the symmetry of the pancake instability, a filament rather than a disc is produced. The growth of instabilities in the filament formed sub-condensations which are recent sites of star formation.

21317 (N—87-15043, pp vp) **H and K maps of two star-forming regions: S 140 and CEP A OB3.** Graadalen, G.L.; Hackwell, J.A.; Gehrz, R.D. (Wyoming Univ., Laramie). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

The molecular clouds near S 140 and Cep A OB3 both contain regions that emit strongly in the infrared but which have relatively little or no emission in radio wavelengths. The lack of radio emission is usually interpreted to mean that little ionization has taken place, and that the IR emission comes from dust heated by a central pre-main sequence object. We have made high resolution maps of these two areas with H and K broadband filters with the 2.3m telescope of the Wyoming Infrared Observatory (WIRO). Our observations were made with an InSb detector using the standard WIRO mapping technique of multiple scanning to construct a series of 64x64 pictures. Our scanning was made in one arcsec steps with a 7 inch aperture to produce a resolution of about 6 sec FWHM. Observations of S 140 by Blair et al (1978) with moderate resolution in J, H, and K, revealed a prominent IR source that they called S 140IR. We have scanned an area surrounding their S 140IR region and have obtained total IR fluxes which are in close agreement with Blair et al. Additional detail corresponds to that seen by Dinerstein et al (1979) at 0.9 microns and Campbell (1986) at 1.0 microns. The large (H-K) values for all components of S 140IR indicates that they are probably embedded in the parent molecular cloud with A(v) = 25 mag and A(K) = 2.2 mag. Recent radio studies of Cep A by Hughes and Wouterloot (1984) and FIR studies by Evans et al (1981) have shown the similarity of Cep A to S 140. There is, however, some emission detected from ionized regions by the radio observations, indicating a slightly more advanced stage of evolution for Cep A. We observed an area around the strongest source in Cep A in both H and K, and the K map is presented. We have identified three sources separate from the main source.

21318 (N—87-15043, pp vp) **Submillimetre molecular line observations of M17: the interaction of an ionisation front and molecular clouds.** Rainey, R.; White, G.J.; Gatley, I.; Hayashi, S.S.; Kaifu, N.; Griffin, M.J.; Monteiro, S.; Cronin, N.J.; Scivetti, A. (United Kingdom Infrared Telescope Unit, Hilo, HI; Nobeyema Solar Radio Observatory, Japan; Newcastle-upon-Tyne Univ., England; Bath Univ., England). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

An area of about 9 by 10 arc minutes in the M17 molecular cloud has been mapped in the J=3-2 transition of CO. The strongest CO emission is observed to come from the two bars to the north and southwest, which lie just outside the area of ionized gas seen in the radio continuum studies. We are viewing the boundary between the ionized and molecular gas almost edge on. The most intense CO emission is from the area around the dense molecular cloud core M17SW in the southwest bar. To the east of M17SW there are signs of recent or continuing star formation including $H_2O$ masers and an ultra-compact HII region. The CO J=3-2 spectra observed are complex with considerable variation in line shapes occuring over distances of less than one arc minute. We interpret the velocity structure of this region as arising from an ensemble of molecular cloud fragments in addition to extended emission. We have identified several cloud components at different velocities within both the northern and southwest bars of CO emission. A simple kinematic model of the cloud components in the southwest bar in which they are considered to be clumps of post-shock gas lying close to the edge of the expanding HII region, with the shock being driven by Kleinmann's star, gives a velocity of approx. 10.8 km s(-1) for the expansion velocity of the HII region, which is currently at a distance of approx. 2.4 pc from Kleinmann's star. The resulting shock is thought to be preceding the ionisation front and appears to have led to the fragmentation of the original cloud.

21319 (N—87-15043, pp vp) **Near-infrared observations of IRAS sources in and near dense cores.** Fuller, G.A.; Myers, P.C.; Mathieu, R.D.; Beichman, C.A.; Benson, P.J.; Schild, R.E. (Center for Analysis, Newport Beach, CA; Wellesley College, MA). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

We report 0.4 to 20 micron photometry of 27 Infrared Astronomy Satellite (IRAS) point sources associated with dense cores in nearby dark clouds. It is found that these objects have a bimodal distribution of spectral slopes. The objects in the group with steep spectral slopes are typically within one half power radius of the core peak and are not visible on the POSS. The remainder of the objects are typically further from their cores, are optically visible and have shallow spectral slopes (s is approximately 0.6). Both the groups of objects have essentially the same luminosity function with median luminosity of 1 to 2 L(solar), which is similiar to the luminosity function for T Tauri stars. The near-infrared (J,H,K,L) colors of the objects have been used to estimate the visual extinction to the stars. This indicates that the typical steep spectrum source has extinction A(upsilon) of approximately 30 magnitudes, which is larger by a factor of 3 to 4 than a uniform core can provide, thus the density must rise steeply in the vicinity of the star. For those objects where optical estimates of the extinction are available the optical estimates are typically smaller than our IR estimates by a factor of 1.6. For multiple scattering by grains that scatter primarily in the forward direction, this implies a grain albedo of 0.4 at V. Using this derived extinction, the FIR emission from a spherical shell with an inverse power law density has been modelled. It is shown that to be consistent with both the observations of the density of the core at a scale of 1.5 x 10(17) cm and the extinction derived from the near-IR colors there must be a circumstellar hole of radius 10-100 A.U. for all density laws with exponents greater than 1.2. It is also shown that a component in addition to the star and circumstellar shell is necessary.

21320 (N—87-15043, pp vp) **Bird: a pressure-confined explosion in the interstellar medium.** Lane, A.P.; Stark, A.A.; Helfand, D.J. (Bell Telephone Labs., Inc., Holmdel, NJ; Columbia Univ., NY). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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The non-thermal radio continuum source G5.3-1.0, mapped at 20 cm with the Very Large Array (VLA) by Becker and Helfand, has an unusual bird-like shape. In order to determine possible interaction of this source with adjacent cold gas, we have mapped this region in the J=1-0 line of CO using the AT and T Bell Laboratories 7m antenna and the FCRAO 14m antenna. The map shown contains 1859 spectra sampled on a 1.5 arcminute grid; each spectrum has an rms noise of 0.2 K in 1 MHz channels. There are

several molecular clouds at different velocities along the line of sight. The outer regions of a previously unknown Giant Molecular Cloud (GMC) at l=4.7 deg., b=-0.85 deg., v=200 km s(-1) appears to be interacting with G5.3-10: the molecular cloud has a bird-shaped hole at the position of the continuum source, except that the brightest continuum point (the bird's head) appears to be embedded in the cloud. The velocity of this GMC indicates it is within 2 kpc of the galactic center. The morphology suggests that a supernova or other explosive event occurred near the outside of the GMC, in a region where (n) is approximately 300 cm(-3), and expanded into a region of lower density and pressure. The pressures, densities, and velocity gradients of molecular clouds near the galactic center are on average higher than those of clouds near the Sun. We therefore expect that Type II supernovae near the galactic center would be distorted by their interactions with their parent molecular clouds.

21321 (N—87-15043, pp vp) **Grain processes in massive star formation.** Wolfire, M.G.; Cassinelli, J.P. (Wisconsin Univ., Madison). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Observational evidence suggests that stars greater than 100 M(solar) exist in the Galaxy and Large Magellanic Cloud (LMC), however classical star formation theory predicts stellar mass limits of only approx. 60 M(solar). A protostellar accretion flow consists of inflowing gas and dust. Grains are destroyed as they are near the central protostar creating a dust shell or cocoon. Radiation pressure acting on the grain can halt the inflow of material thereby limiting the amount of mass accumulated by the protostar. We first consider rather general constraints on the initial grain to gas ratio and mass accretion rates that permit inflow. We further constrain these results by constructing a numerical model. Radiative deceleration of grains and grain destruction processes are explicitly accounted for in an iterative solution of the radiation-hydrodynamic equations. Findings seem to suggest that star formation by spherical accretion requires rather extreme preconditioning of the grain and gas environment.

21322 (N—87-15043, pp vp) **Lower mass limit of an evolving interstellar cloud and chemistry in an evolving oscillatory cloud.** Tarafdar, S.P. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Simultaneous solution of the equation of motion, equation of state and energy equation including heating and cooling processes for interstellar medium gives for a collapsing cloud a lower mass limit which is significantly smaller than the Jeans mass for the same initial density. The clouds with higher mass than this limiting mass collapse whereas clouds with smaller than critical mass pass through a maximum central density giving apparently similar clouds (i.e., same Av, size and central density) at two different phases of its evolution (i.e., with different life time). Preliminary results of chemistry in such an evolving oscillatory cloud show significant difference in abundances of some of the molecules in two physically similar clouds with different life times. The problems of depletion and short life time of evolving clouds appear to be less severe in such an oscillatory cloud.

21323 (N—87-15043, pp vp) **Jeans criterion in a turbulent medium.** Bonazzola, S.; Falgarone, E.; Heyvaerts, J.; Perault, M.; Puget, J.L. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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According to the classical Jeans analysis, all the molecular clouds of mass larger than a few 100 M(solar), size larger than about 1pc and kinetic temperature Tk less than 30K, are gravitationally unstable. We have shown that in clouds supported by internal supersonic motions, local gravitational instabilities may appear within molecular clouds which are globally stable. The argument is threefold: (1) when the turbulent kinetic energy is included into the internal energy term, the virial equilibrium condition shows that molecular clouds such as those observed, which are gravitationally unstable according to the Jeans criterion, are indeed globally stable if supported by a turbulent velocity field of power spectrum steeper than 3; (2) 2D compressible hydrodynamical simulations show that a supersonic turbulent velocity field generates a turbulent pressure within clouds, the gradients of which stabilize the unstable scales (i.e., the largest scales and the cloud itself) against gravitational collapse; (3) an analysis similar to the Jeans approach but including the turbulent pressure gradient term, gives basically the same results as those given in (1). Clouds of mean density lower than a critical value are found to be stable even though more massive than their Jeans mass. In clouds of mean density larger than that critical value, the gravitational instability appears only over a range of scales smaller than the cloud size, the largest scales being stable. In practice, the observed mean densities are lower than this critical value: the observation of a small number of cores and stars of a few solar masses embedded in clouds of several hundred solar masses can only be understood in terms of small scale density fluctuations of large amplitude generated by the supersonic turbulence which would occasionally overtake the limit of gravitational stability.

21324 (N—87-15043, pp vp) **Spectral evolution of young stellar objects.** Adams, F.C. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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An evolutionary sequence, from protostars to pre-main-sequence stars, is suggested for the classification of young stellar objects. This sequence is derived by comparing the predictions of the theoretical models of Adams and Shu with the morphological classification scheme of Lada and Wilking. We first define the spectral index in the near- and mid-infrared, n is identical to d log(nu F sub nu)/d log nu, and then interpret the class of sources with negative spectral indices as protostars. The inferred mass infall rates for these objects are generally consistent with the measured gas temperatures of approx. 35 K in Ophiuchus, and of approx. 10 K in Taurus. Fitting the data requires us to adopt cloud rotation rates in Ophiuchus, which are typically an order of magnitude greater than in Taurus, and we speculate on the mechanistic origin for this difference. Next, we consider a subclass of T Tauri stars with near- and mid-infrared excesses and positive or zero spectral indices. We find that the objects with the steeper indices can be understood as the post-infall products from the collapse of rotating cloud cores, where the infrared excesses arise from the simple reprocessing of visible stellar photons in optically thick but spatially thin disks. The sources with flatter spectra may require massive accretion disks. Given the existence of protostars and naked star/disk systems, there is a natural interpretation of another subclass of T Tauri stars, those with two peaks in their emergent spectral energy distributions. These are readily explained as intermediate cases in which dust envelopes still surround the stars and disks. Finally, we find that the theory can be extended to explain the spectral energy distribution of FU Orionis. Our model suggests that FU Orionis has a disk, but it offers no discrimination between the coming ideas that the outburst took place on the star or in the disk.

21325 (N—87-15043, pp vp) **Supershells and propagating star formation.** Maclow, M.M.; Mccray, R.; Kafatos, M. (George Mason Univ., Fairfax, VA). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Correlated supernovae from an OB association can carve large cavities (greater than 100 pc) in the interstellar medium (ISM), and can punch holes completely through the disk of a spiral galaxy. Supernova remnant energy within such a cavity is thermalized before the shock reaches the supershell. Thus stellar wind theory may be used to model these superbubbles. We describe how the evolution of the superbubble depends on the density distribution of the galactic disk gas and the rate of supernovae in the OB association. At a radius of 100 to 300 pc, the supershell becomes gravitationally unstable, forming giant molecular clouds which are the sites for new star formation. This gravitational instability of the su-

pershells provides a physical mechanism for propagating star formation and may account for the observation of bursts of star formation in galaxies.

21326 (N—87-15043, pp vp) **Size-density relations in dark clouds: Non-LTE effects.** Maloney, P. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

One of the major goals of molecular astronomy has been to understand the physics and dynamics of dense interstellar clouds. Because the interpretation of observations of giant molecular clouds is complicated by their very complex structure and the dynamical effects of star formation, a number of studies have concentrated on dark clouds. Leung, Kutner and Mead (1982) (hereafter LKM) and Myers (1983), in studies of CO and $NH_3$ emission, concluded that dark clouds exhibit significant correlations between linewidth and cloud radius of the form delta v varies as R(0.5) and between mean density and radius of the form n varies as R(-1), as originally suggested by Larson (1981). This result suggests that these objects are in virial equilibrium. However, the mean densities inferred from the CO data of LKM are based on an local thermodynamic equilibrium (LTE) analysis of their 13CO data. At the very low mean densities inferred by LKM for the larger clouds in their samples, the assumption of LTE becomes very questionable. As most of the range in R in the density-size correlation comes from the clouds observed in CO, it seems worthwhile to examine how non-LTE effects will influence the derived densities. Microturbulent models of inhomogeneous clouds of varying central concentration with the linewidth-size and mean density-size relations found by Myers show sub-thermal excitation of the 13CO line in the larger clouds, with the result that LTE analysis considerbly underestimates the actual column density. A more general approach which doesn't require detailed modeling of the clouds is to consider whether the observed T/sub R/*(13CO)/T/sub R/*(12CO) ratios in the clouds studied by LKM are in the range where the LTE-derived optical depths be seriously in error due to sub-thermal excitation of the 13CO molecule.

21327 (N—87-15043, pp vp) **Unstable 06.5f.p star HD 148937 and its interstellar environment.** Leitherer, C.; Chavarria-K., C. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

The massive, early-type star HD 148937 (spectral type 06.5.p) is surrounded by a unique set of nebulosities. A spherically symmetric Stromgren sphere (Radius approx. - 25 pc), an ellipsoidal filamentary nebulosity (semimajor axis approx. - 5 pc) interpreted as a stellar-wind-blown shell, and a bipolar nebular complex (semimajor axis approx. - 1 pc) with HD 148937 located in the apparent center of symmetry. Observations of these nebulosities are reported (narrow-band charge coupled devices imaging, image dissector scanner (IDS) spectrophotometry, high resolution spectroscopy) in an attempt to establish a consistent model of HD 148937 and its nebulosities.

21328 (N—87-15043, pp vp) **Turbulence in HII regions.** Odell, C.R. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

It has been known for many decades that the Reynolds number in HII regions must be very high and that the corresponding fine scale flow must be turbulent. Even though the theoretical relation between turbulent element separation and random velocity was derived by Kolmogoroff over forty years ago, there have been only a few attempts to test this theory and its corresponding assumptions. An attempt by Munch for M42 with marginal velocity resolution lead to ambiguous results, although more recent studies by Jean Rene Roy and his colleagues have been more credible. The internal velocities of a number of HII regions were systematically studied and the theory was tested with considerable certainty. The results should be important for the determination of the energy balance of HII regions and the relation of small scale motion to the process of star formation.

21329 (N—87-15043, pp vp) **CO near the Pleiades: encounter of a star cluster with a small molecular cloud.** Bally, J.; White, R.E. (Smith College, Northampton, MA). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Although there is a large amount of interstellar matter near the Pleiades star cluster, the observed dust and gas is not a remnant of the placental molecular cloud from which the star cluster was formed. Carbon monoxide (CO) associated with the visible reflection nebulae was discovered by Cohen (1975). Its radial velocity differs from that of the cluster by many times the cluster escape velocity, which implies that the cloud-cluster association is the result of a chance encounter. This circumstance and the proximity of the Pleiades to the sun creates an unique opportunity for study of interstellar processes at high spatial resolution. To study the molecular component of the gas, a 1.7 square degree field was mapped with the AT&T Bell Laboratories 7-meter antenna (1.7' beam) on a 1' grid in the J=1.0 C(12)O line, obtaining over 6000 spectra with 50 kHz resolution. The cloud core was mapped in the J=1-0 line of C(13)O. Further observations include an unsuccessful search for CS (J=2-1) at AT&T BL, and some C(12)O J=2-1 spectra obtained at the Millimeter Wave Observatory of the University of Texas.

21330 (N—87-15043, pp vp) **Optical observations of very low ionization HII regions in the large Magellanic cloud.** Pena, M.; Ruiz, M.T.; Rubio, M. (Chile Univ., Santiago). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Several very low ionization isolated HII regions were detected on a prism-objective plate of the Large Magellanic Cloud. Most of the objects show a very weak (OIII) lambda 5007 emission line but the (OII) lambda 6584 doublets are very intense. This kind of object seems to be ideal in order to determine accurate N and O abundance, avoiding the use of large ionization correction factors in the N abundance determination. Spectrophotometric observations of these regions were carried out with the 4 m telescope and the 2-D Frutti spectrograph at Cerro Tololo, and with the 1.52 m and the Image Dissector Scanner (IDS) at La Silla, ESO. The wavelength range lambda 3700 to 7000 A was covered. Calibrated fluxes of the emission lines detected were measured, and from these data preliminary results of physical conditions of the gas as well as some ionic abundances were derived. Comparisons of the observations with ionization structure models show that the effective temperatures of the ionizing stars are less than 35,000 K. Possible abundances gradients across the large megallanic cloud are discussed.

21331 (N—87-15043, pp vp) **Non-equilibrium ionization around clouds evaporating in the interstellar medium.** Ballet, J.; Luciani, J.F.; Mora, P. (Ecole Polytechnique, Palaiseau, France). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

It is of prime importance for global models of the interstellar medium to know whether dense clouds do or do not evaporate in the hot coronal gas. The rate of mass exchanges between phases depends very much on that. McKee and Ostriker's model, for instance, assumes that evaporation is important enough to control the expansion of supernova remnants, and that mass loss obeys the law derived by Cowie and McKee. In fact, the geometry of the magnetic field is nearly unknown, and it might totally inhibit evaporation, if the clouds are not regularly connected to the hot gas. Up to now, the only test of the theory is the U.V. observation (by the Coperni-

cus and IUE satellites) of absorption lines of ions such as OVI or NV, that exist at temperatures of a few 100,000 K typical of transition layers around evaporating clouds. Other means of testing the theory are discussed.

21332 (N—87-15043, pp vp) **Near-infrared spectroscopy of planetary nebulae: how strong is the $H_2$ emission?.** Dinerstein, H.L.; Carr, J.; Harvey, P.M.; Lester, D.F. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

In an effort to understand the systematics of the $H_2$ emission from planetary nebulae, a program of near-infared spectroscopy using the University of Texas infrared reticon spectrometer was started. This instrument has a 1x32 element InSb photodiode array as a detector. All of the observations reported were made on the McDonald Observatory 2.7 m telescope, with spectra resolving power lambda/delta lambda = 600. The spectral coverage allows the measurement strengths of Brackett gamma He I 2.113 microns, HE II 2.189 microns and the v = 1=0 S(1) line of $H_2$ at 2.122 microns. One of the most important advantages of this instrument is that we are able to resolve $H_2$ from the adjacent He I line. Most previous observations of planetaries have been made at spectral resolving powers of about 100, which blend these lines. The contribution of the He I line has generally been dismissed as being unimportant, but we show that this may not be valid. Our higher resolving power also improves the line-to-continuum contrast; in some cases, the continuum is the limiting factor in detecting faint lines.

21333 (N—87-15043, pp vp) **Infrared spectra of WC10 planetary nebulae nuclei.** Wooden, D.H.; Cohen, M.; Bregman, J.D.; Witteborn, F.C.; Rank, D.M.; Allamandola, L.J.; Tielens, G.G.M. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

The 5.2 to 8.0 micron spectra are presented for two planetary nebulae nuclei Hen1044 (He2-113) and CPD-56 8032. The unidentified infrared (UIR) emission bands at 6.2 microns, 6.9 microns, 7.7 microns are present in the spectra of Hen1044 and in CPD-56 8032, and the 8.6 micron band is present in the long wavelength shoulder of the 7.7 micron band in the spectrum of CPD-56 8032. The 8 to 13 micron spectra of these two stars by Aitken et. al. clearly show the presence of the 8.6 micron band in He2-113 while weakly resolving this feature in the spectra of CPD-56 8032. In their spectra the 11.3 micron band is also clearly detected in both objects. The 6.2 micron and 7.7 micron bands are characteristic of the infrared active C-C stretching modes in polycyclic aromatic hydrocarbons (PAHs); the 3.3 micron, 8.6 micron, and 11.3 micron bands are respectively assigned to the in-plane stretching mode, the in-plane bending mode, and the out-of-plane bending mode of the aromatic CH bond. The weak 6.9 micron emission feature is attributed to the UIR spectrum by Bregman et. al. The IRAS LRS spectra of He2-113 (IRAS 14562-5406) and CPD-56 8032 (IRAS 17047-5650) are presented. Cohen et. al. identify the broad plateau from 11.3 to 13.0 microns in the spectrum of He2-113 with increased hydrogenation of PAHs. This broad plateau is not seen in the LRS spectrum of CPD-56 8032. Also, He2-113 has greater infrared excess emission in the 17-22 micron region than does CPD-56 8032.

21334 (N—87-15043, pp vp) **Planetary nebulae and the interstellar medium.** Aller, L.H. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

In addition to available published data on planetary nebulae (PN), some 40 objects largely concentrated towards the galactic center and anticenter regions were included. All were observed with the Lick 3(sup m) telescope and image tube scanner. Abundances of C, N, O, Ne, Cl, and Ar were determined by a procedure in which theoretical models were used to obtain ionization correction factors (ICF). Of the 106 PN, 66 are N-rich and 40 are N-poor. There appear to be no significant differences between the average compositions in the solar neighborhood and the average taken over the entire observable portion of the galaxy.

21335 (N—87-15043, pp vp) **High-resolution mapping of mass loss from highly evolved carbon stars.** Ball, R. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Abstract Only.

The molecular component of the mass outflow at high resolution was mapped with the Owens Valley Millimeter-Wave Interferometer in two well-known objects, CRL 2688 and CIT 6. Interferometric observations of a pair of carbon stars which are evolving toward the planetary nebula stage have revealed evidence of episodic, nonspherically symmetric mass loss, and may lead to a fuller understanding of shielding properties of the dust grains involved in these flows.

21336 (N—87-15043, pp vp) **Mass return to the interstellar medium from highly-evolved carbon stars.** Latter, W.B.; Thronson, H.A., Jr.; Hacking, P.; Bally, J.; Black, J. (Wyoming Univ., Laramie; Bell Telephone Labs. Inc., Holmdel, NJ). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Abstract Only.

Data produced by the Infrared Astronomy Satellite (IRAS) was surveyed at the mid- and far-infrared wavelengths. Visually-identified carbon stars in the 12/25/60 micron color-color diagram were plotted, along with the location of a number of mass-losing stars that lie near the location of the carbon stars, but are not carbon rich. The final sample consisted of 619 objects, which were estimated to be contaminated by 7 % noncarbon-rich objects. The mass return rate was estimated for all evolved circumstellar envelopes. The IRAS Point Source Catalog (PSC) was also searched for the entire class of stars with excess emission. Mass-loss rates, lifetimes, and birthrates for evolved stars were also estimated.

21337 (N—87-15043, pp vp) **Clumpy circumstellar medium around young supernova remnants.** Dickel, J.R.; Jones, E.M.; Eilek, J.A. (Los Alamos National Lab., NM; New Mexico Institute of Mining and Technology, Socorro). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Each of the youngest supernova remnants known in the Milky Way, Cas A, Kepler's SNR, and Tycho's SNR, shows a different morphological structure caused by different conditions in the progenitor stars and their surroundings. In all three cases, however, the observed shells have a thickness of about 1/4 the radius, a sharp outer edge, and significant brightness irregularities. These features require that the circumstellar medium be highly clumped. To investigate the phenomenon, models of the expansion have been constructed using a one-dimensional spherical hydrodynamic code. As a supernova shock moves down the external density gradient of the star, material behind the shock begins to go into free expansion. Then as surrounding material is encountered a reverse shock moving back into the ejectum will be formed. Until the expansion has swept up about eight times the ejected mass when the situation can be considered as a point explosion in its surroundings, the dynamics are controlled by conditions between the shocks. The region is also where the synchrotron radio emission from relativistic electrons trapped in magnetic fields arises. Initial particles and fields are accelerated and amplified by eddy motion at the interface between the ejected and swept-up material and at the boundaries of clumps. Polarimetry shows that these SNR have a net radial orientation of their magnetic fields apparently from stretching by Ray-

leigh-Taylor instabilities at the contact surfaces. Without clumps the observed shell is much too narrow and steep on the inside.

21338 (N—87-15043, pp vp) **Molecular gas in the supernova remnant IC443.** Huang, Y.L.; Dickman, R.L.; Snell, R.L. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Although a few highly perturbed regions characterized by gas motions with velocities larger than 20 km/s have been discovered during the last several years in the supernova remnant (SNR) IC 443, the nature of these perturbed clumps and their relationship to the quiescent molecular gas near the SNR remains unknown. In part, this is due to a lack of large-scale, high angular resolution observations. Therefore, a systematic survey of this SNR in the CO (J=1 yields 0) line has been conducted, covering a roughly 50′ x 50′ region spaced by 2′. The observations were made with the 14 m telescope of the Five College Radio Astronomy Observatory (FCRAO), which has a resolution of 45″ and a single sideband receiver temperature of 200 K at 2.6 mm wavelength. Five new clumps were discovered, bringing the total number of known perturbed regions to eight. To study the physical structure of these clumps in more detail, more complete maps of the clumps have been made in both the CO(J=1 yields 0) and (J=2 yields 1) transitions with the FCRAO telescope. These maps show that the extent of perturbed gas in a typical clump is several arcmin, or a few pc at a distance of 1.5 kpc.

21339 (N—87-15043, pp vp) **Observational discrimination between modes of shock propagation in interstellar clouds: predictions of CH+ and SH+ column densities in diffuse clouds.** Flower, D.R.; Desforets, G.P.; Roueff, E.; Hartquist, T.W. (Observatoire de Paris-Meudon, France; Max-Planck-Institute fuer Extraterrestrische Physik, Munich, West Germany). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Considerable effort in recent years has been devoted to the study of shocks in the diffuse interstellar medium. This work has been motivated partly by the observations of rotationally excited states of $H_2$, and partly by the realization that species such as CH(+), OH and $H_2O$ might be formed preferentially in hot, post-shock gas. Transverse magnetic fields above a critical strength give rise to an acceleration zone or precursor, in which the parameters on the flow vary continuously. Chemical reactions, which change the degree of ionization of the gas, also modify the structure of the shock considerably. Recent work has shown that large column densities of CH(+) can be produced in magnetohydrodynamic shock models. Shock speeds U/sub s/ approx. = 10 km/s and initial magnetic field strengths of a few micro G are sufficient to produce ion-neutral drift velocities which can drive the endothermic C(+)($H_2$,H)CH(+) reaction. It was also shown that single-fluid hydrodynamic models do not generate sufficiently large column densities of CH(+) unless unacceptably high shock velocities (u/sub s/ approx. 20 km/s) are assumed in the models. Thus, the observed column densities of CH(+) provide a constraint on the mode of shock propagation in diffuse clouds. More precisely, they determine a lower limit to the ion-neutral drift velocity.

21340 (N—87-15043, pp vp) **CS J = 2 1 survey of the galactic center region.** Stark, A.A.; Bally, J.; Dragovan, M.; Wilson, R.W. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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A CS map of the galactic center region is presented consisting of 15,000 spectra covering -1 deg. less than 3. deg. 6 min., -0 deg.4 min. less than b less than 0 deg. 4 min., each having an rms noise of 0.15 K in 1 MHz filters. CS is a high-excitation molecule, meaning that it is excited into emission only when the ambient density is less than n much greater than or approx. 2 x 10 to the 4th power/cu cm CS emission in the inner 2 deg. of the galaxy is nearly as pervasive as CO emission, in stark contrast to the outer galaxy where CS emission is confined to cloud cores. Galactic center clouds are on average much more dense than outer Galaxy clouds. This can be understood as a necessary consequence of the strong tidal stresses in the inner galaxy.

21341 (N—87-15043, pp vp) **Aperture synthesis observations of the molecular ring in the galactic center.** Guesten, R.; Genzel, R.; Wright, M.C.H.; Jaffe, D.T.; Stutzki, J. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Reported are 88 GHz aperture synthesis observations of HCN J=1 yields 0 emission and absorption in the central 5 pc of the Galaxy. The data, taken by the Hat Creek mm-interferometer at 5″ to 10″ spatial and 4 km/s spectral resolution, show a complete, clumpy ring of molecular gas surrounding the ionized central 2 pc of the Galaxy. The ring is the inner edge of a larger disk extending to about 5 pc. Comparison with sub-mm line data suggests that the HCN 1-0 line is slightly optically thick and originates in subthermally populated gas. The clumpy line emission distribution reflects a combination of hydrogen volume and column density variations. The new data clearly show a close physical relation between the molecular and the ionized gas in the central cavity. The western arc appears to be the ionized inner surface of the molecular ring, and the northern arm and bar may be streamers of ionized gas falling from the ring toward the center. The dominant large scale velocity pattern of the majority of the molecular gas in the inner 5 pc is rotation. No overall radial motion of the ring greater than about 20 km/s is apparent. The rotation is perturbed in several ways; (1) there is a very large local velocity dispersion, (2) the ring shows changes in position angle and inclination (warps), (3) there is a bright, redshifted cloud which appears to be located in the western part of the ring but does not participate in the rotation. These characteristics and the high degree of clumpiness indicate a non-equilibrium configuration of short (less than or approx. 10 to the 4th power to 10 to the 5th power y) dynamical lifetime. The warping and tilting of the structure and the short dynamical lifetime make an accurate determination of equilibrium rotation velocity uncertain.

21342 (N—87-15043, pp vp) **IUE absorption studies of broad- and narrow-line gas in Seyfert galaxies.** Voit, G.M.; Shull, J.M.; Begelman, M.C. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

The interstellar medium of a galaxy containing an active nucleus may be profoundly affected by the high energy (x-ray, EUV) continuum flux emanating from the central source. The energetic source may photoionize the interstellar medium out to several kiloparsecs, thereby creating a global H II region. The International Ultraviolet Explorer (IUE) satellite has attempted to observe in several Seyfert galaxies (NGC 3516, NGC 4151, NGC 1068, 3C 120) the narrow absorption lines expected from such global H II regions. Instead, in two of the galaxies (NGC 3516, NGC 4151) broad, variable absorption lines at C IV lambda 1550, N V lambda 1240, and Si IV lambda 1400 were found, as well as weaker absorption features at O I lambda 1302 and C II lambda 1335. These features swamp any possible global H II region absorption. Such broad absorption features have previously been observed in IUE data, but their origin is still not well understood.

21343 (N—87-15043, pp vp) **Cold atomic hydrogen in the inner galaxy.** Dickey, J.M.; Garwood, R.W. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

The VLA is used to measure 21 cm absorption in directions with the absolute value of b less than 1 deg., the absolute value of l less than 25 deg. to probe the cool atomic gas in the inner galaxy. Abundant H I absorption is detected; typical lines are deep and narrow, sometimes blending in velocity with adjacent features. Unlike 21 cm emission not all allowed velocities are covered: large portions of the l-v diagram are optically thin. Although not similar to H I emission, the absorption shows a striking correspondence with CO emission in the inner galaxy: essentially every strong feature detected in one survey is seen in the other. The provisional conclusion is that in the inner galaxy most cool atomic gas is associated with molecular cloud complexes. There are few or no cold atomic clouds devoid of molecules in the inner galaxy, although these are common in the outer galaxy.

21344 (N—87-15043, pp vp) **Neutral hydrogen cloud distances and the strength of the interstellar magnetc field.** Verschuur, G.L. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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If HI clouds exist in pressure equilibrium in an environment where gas pressure is a function of z-distance and if HI cloud density is a function of z-distance, it can be shown that a quantity called the Virial Measure is a function of z-distance. The Virial Measure is that distance at which a cloud would be in gravitational equilibrium if its internal kinetic temperature is indicated by profile linewidth. The Virial Measure is derived from observed cloud parameters and has been calibrated for clouds of known distance so that it can be used to determine the distance to other HI clouds. The magnitude of various terms in the virial equation can thus be derived for several hundred HI clouds. It is demonstrated that the strength of the interstellar magnetic field is a function of z-distance.

21345 (N—87-15043, pp vp) **Molecular content of the nearby galaxy from IRAS and HI observations.** Bazell, D.; Desert, F.X. (Applied Research Corp., Landover, MD). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Because infrared emission is a very good tracer of mass at high latitudes, by combining it with HI observations it provides a convenient though indirect way of observing the spatial distribution of molecular material. Moreover, these observations will premit placing limits on the fraction of total infrared luminosity emitted by dust associated with molecular and atomic hydrogen clouds. A preliminary result from the study of the correlation between HI column density and 100 micron infrared flux density as measured by the IRAS satellite is reported. The ratio F100/W(HI) = R has an average value of roughty 17 KJy/sr/(K km/s) over the whole sky. Bright regions in the FIR such as the Galactic plane and HII regions are excluded from the data. The histogram of the number of pixels vs R has a strong peak near 17 (same units as before) and is asymmetric about this mean value, having a tail at higher values of R. This basic shape is fairly independent of the region of the sky we observe. The peak confirms the general correlation between infrared emission and HI column density reported previously. One way to explain the shape of the distribution is to assume a constant dust to gas mass ratio and a constant interstellar radiation field and associate points in the tail with molecular clouds. In this case the ratio R is higher for points in the tail because it does not account for the column density of molecular hydrogen.

21346 (N—87-15043, pp vp) **Milky Way halo gas kinematics.** Danly, L. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Measurements of high resolution, short wavelength absorption data taken by IUE toward high latitude O and B stars are presented in a discussion of the large scale kinematic properties of Milky Way Halo gas. An analysis of these data demonstrates that: (1) the observed absorption widths (FWHM) of Si II are very large, ranging up to 150 Km/s for the most distant halo star; this is much larger than is generally appreciated from optical data; (2) the absorption is observed to be systematically negative in radial velocity, indicating that cool material is, on the whole, flowing toward the disk of the galaxy; (3) there is some evidence for asymmetry between the northern and southern galactic hemispheres, in accordance with the HI 21 cm data toward the galactic poles; (4) low column density gas with highly negative radial LSR velocity (V less than -70 km/s) can be found toward stars beyond 1-3 kpc in the northern galactic hemisphere in all four quadrants of galactic longitude; and (5) only the profiles toward stars in the direction of known high velocity HI features show a clear two component structure.

21347 (N—87-15043, pp vp) **IRAS observations of giant molecular clouds in the Milky Way.** Mozurkewich, D.; Thronson, H.A., Jr. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

The IRAS data base has been used to study infrared radiation from molecular clouds in our galaxy. The sample of clouds was restricted to those with reliably determined molecular masses from large area, multi-isotope CO maps. They were normalized to X(CO-13)= 2x10 to the -6. Flux densities at 60 microns and 100 microns were determined by integrating the flux density within rectangles drawn on the sky flux plates after subtracting a suitable background. The rectangles were chosen to be coextensive with the areas mapped in CO. Color corrections were made and luminosites calculated by assuming the optical depths were proportional to frequency. The flux densities were converted to dust masses with a value for 4a rho/3Q = .04 g/cm at 100 microns.

21348 (N—87-15043, pp vp) **Spiral arms and massive star formation: analysis of the CO face-on pictures of the galaxy.** Clemens, D.P.; Sanders, D.B.; Scoville, N.Z. (California Institute of Technology, Pasadena). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

The face-on distribution of molecular gas in the first Galactic quadrant, derived from the Massachusetts-Stony Brook Galactic Plane CO Survey, was compared to the Galactic distribution of giant radio HII regions. The HII regions were found to preferentially select gas regions of higher than average density (more than twice the mean) and showed a strong correlation with the second power of the gas density. Systematic effects were tested with a Monte Carlo simulated HII region distribution and found to be negligible. The 135 HII regions were selected from the radio catalogs of Downes et at. (1980) and Wink et al. (1982). The HII regions were required to be within the CO survey l and b limits, within the solar circle, and not part of the 3 kpc expanding arm. The velocities of the HII regions were tabulated by the catalog authors and obvious associations with known objects and $H_2CO$ absorptions were used by them to assign distances. The distance assignments were here grouped into two categories; (1) those HII regions with definite distance assignments (85 objects); and (2) those HII regions with less secure distance assignments and those for which no near-far assignment was possible (50 objects).

21349 (N—87-15043, pp vp) **Velocity dispersion of the giant molecule clouds: a viscous origin.** Jog, C.J.; Ostriker, J.P. (Princeton Univ., NJ). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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The observations of interstellar cloud motion show that the cloud velocity dispersion is nearly constant, to within a factor of 2,

for clouds covering at least three orders of magnitude in mass. For example, the Giant Molecular Cloud (GMC) with typical masses of approx 5 x 10 to the 5th power solar masses have a one-dimensional planar, cloud-cloud, random velocity dispersion of approx 3-7 km/s. The HI clouds, of approx. 400 solar masses each, on the other hand, have a typical one-dimensional velocity dispersion of approx 6 km/s. Clearly, the clouds are not in kinetic energy equipartion. The GMC spatial distribution in the galactic disk is not that of an isolated, 3-D system; rather, the GMCs exhibit a very thin disk (approx nearly a monolayer) distribution; with the ratio of the diameter of a typical GMC to the vertical scale-height of the GMC distribution being approx 50 pc/150 pc = 0.3. The supernova shocks, which can accelerate the low mass clouds, are extremely ineffective in accelerating the GMCs because of the much larger mass/area ratio for the GMCs. The above points suggest that the GMCs do not constitute an isolated, 3-D system - rather, they indicate that the dynamics of the GMCs is mainly determined by the fact that they are located in a differentially rotating galactic disk, and that, as for particles in planetary rings, viscosity is the primary energy input. Specifically, it is proposed that gravitational scattering of the massive clouds off each other in the differentially rotating galactic disk constitutes an effective gravitational viscosity, which causes an increase in the random kinetic energy of the GMCs at the expense of their ordered, rotational kinetic energy.

21350 (N—87-15043, pp vp) **Local interstellar gasdynamical stability in spiral arm flow.** Balbus, S.A. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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The stability of two-dimensional interstellar gas flow passing through a spiral potential has been investigated. The background flow is assumed to move in a tightly wound potential, which may be regarded as external or self-generated. The unperturbed flow, which may be time dependent, is self-gravitating and satisfies the Roberts equations of motion. A polytropic, single-fluid assumption has been used. Magnetic effects are not considered. The motivation behind this work is to try to understand how much of the diversity of spiral arm morphology can be understood by large scale gas dynamical processes alone. To this end, it is suggested that spurring and feathering, and forming molecular cloud complexes may be closely related in the sense of having dynamically similar origins.

21351 (N—87-15043, pp vp) **(32)S/(33)S abundance as a function of galactocentric radius in the Milky Way.** Greenhouse, M.A.; Thronson, H.A., Jr. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Astration of heavy elements by the stars of the Milky Way forms a fossil record which may preserve spacial distribution of the mass function for the stars in the galaxy. Sulfur is among the last common element for which the relative abundance of its various isotopes have yet to be completely measured within our galaxy. Explosive oxygen burning in massive stars is thought to be the process which dominates sulfur production within stars. There models predict that the various isotopes (S-32, S-33, S-34) are formed in relative abundance which depend strongly upon the mass of the parent star. This relative abundance is thought to be unaffected by subsequent stellar procesing since all important sinks of sulfur destroy it without regard for isotopic form. Hence the spacial variation of the mass function (MF) can be studied by measuring the abundance variation of sulfur isotopes in the galaxy provided that the product yields for these isotopes are known accurately as a function of stellar mass.

21352 (N—87-15043, pp vp) **OH abundance enhanced in tidally distorted galaxies?.** Schmelz, J.T. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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An extensive survey of 240 galaxies for hydroxyl absorption has been completed using the Arecibo Observatory. These galaxies were used to compile a sample to test for statistical correlations between the optical depth of the 1667 MHz hydroxyl line and various parameters of the parent galaxy. To be included in the sample, the radio flux density of the galaxy at 1667 MHz had to be between 20 mjy and 1000 mjy and the galactic declination between 0 and 38 deg. Since this sample contains mainly non-detections, statistical methods for astronomical data with upper limits as previously described were used to obtain correlation and regression information. Preliminary studies indicate a strong correlation between OH optical depth and infrared to blue luminosity ratio (L sub IR/L sub B), where the infrared data were obtained from the Cataloged Galaxies and Quasars Observed in the IRAS Survey. A second correlation is seen between the optical depth of the 1667 MHz line and galactic type, where a number from 1 to 15 (Elliptical to peculiar, distorted, or interacting) has been assigned to each galaxy. So, stable, isolated galaxies tend not to have detectable hydroxyl. On the other hand, galaxies with more gas and dust, galaxies with a more peculiar or distorted appearance, and galaxies which are more tidally interacting tend to have much more detectable OH. These findings could indicate that these dusty, peculiar, distorted, and interacting galaxies could be the site of large amounts of shocked material where OH is likely to form. Hence, the hydroxyl abundance could be enhanced in these regions of shocked material making the detection of OH in these tidally distorted galaxies much more likely.

21353 (N—87-15043, pp vp) **6 CM OH absorption in megamaser galaxies.** Henkel, C.; Guesten, R.; Baan, W. (Arecibo Ionospheric Observatory, Puerto Rico). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Absorption in the 2Pi sub 1/2 J = 1/2 Lambda doublet transitions of OH, 182 K above the ground state, is detected in the megamaser galaxies IC 4553 (Arp 220), MK 231, MK 273, MGC 3690, and IRAS 17208-0014. The 4660, 4751, and 4766 MHz lines have intensity ratios moderately deviating from the LTE values (1:2:1). The OH rotational temperatures appear to be close to the temperature of the dust, approx. 60 K. The common characteristics of these galaxies (absence of 6 cm inversion, the optical depths, the infrared properties, the systematic trends in the line parameters, and the rotational temperatures) all suggest that the same pump process is responsible for the 18 cm line inversion in the five megamaser sources. The inversion is probably not due to an excitation mechanism involving collisions with HI or $H_2$. While excitation via photodissociation of $H_2O$ cannot entirely be ruled out, the most likely mechanism is considered to be to be a combination of the intense FIR field (populating higher excited OH rotational states) and the non-thermal radiation from the nuclei of the parent galaxies (affecting the excitation within the Lambda -doublets). According to an LVG model of the OH excitation of IC4553, the OH-cloud(s) have to be located close, within 200 to 300 pc, to the center of the galaxy. The excitation of the individual 18 cm lines depends critically on the effective background radiation field and hence on the galactocentric distance of the masing clump. With increasing distance first the 1720 MHz and then the 18 cm main line inversion is quenched, while 1612 MHz inversion is obtained up to approx. 600 pc. The 1612 MHz satellite line is predicted to be more intense than the 1720 MHz line. A critical test for our excitation model is to observe the 2 Pi 3/2 J = 5/2 Lambda-doublet transitions which are predicted to be detectable in absorption.

21354 (N—87-15043, pp vp) **Molecular hydrogen in the young starburst in NGC 253.** Rieke, G.H.; Lebofsky, M.J.; Walker, C.E. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Shocked molecular hydrogen has been observed around the nucleus of the nearby galaxy, NGC 253. This galaxy has a relatively modest luminosity (approx. 3 x 10 to the 10th power solar luminosities) and appears to have no distortions or companions that would indicate a possible interaction. The energy of the galaxy ap-

pears to be derived primarily from a starburst. Thus, our observations have caused us to examine the starburst process in some detail to identify how the molecular hydrogen is excited. It is proposed that the molecular hydrogen emission is produced by collisions of dense molecular clouds accelerated by supernovae explosions. Within the nucleus, this process occurs early in the life of the starbust. This suggest a sequence of nuclear starburst development; examples along this sequence from young to old would include NGC 253, M82, NGC 1097, and M31.

21355 (N—87-15043, pp vp) **Chemical evolution in spiral and irregular galaxies.** Torres-Peimbert, S. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

A brief review of models of chemical evolution of the interstellar medium in our galaxy and other galaxies is presented. These models predict the time variation and radial dependence of chemical composition in the gas as function of the input parameters; initial mass function, stellar birth rate, chemical composition of mass lost by stars during their evolution (yields), and the existence of large scale mass flows, like infall from the halo, outflow to the intergalactic medium or radial flows within a galaxy. At present there is a considerable wealth of observational data on the composition of HII regions in spiral and irregular galaxies to constrain the models. Comparisons are made between theory and the observed physical conditions. In particular, studies of helium, carbon, nitrogen and oxygen abundances are reviewed. In many molecular clouds the information we have on the amount of $H_2$ is derived from the observed CO column density, and a standard $CO/H_2$ ratio derived for the solar neighborhood. Chemical evolution models and the observed variations in O/H and N/O values, point out the need to include these results in a $CO/H_2$ relation that should be, at least, a function of the O/H ratio. This aspect is also discussed.

21356 (N—87-15043, pp vp) **Identification of polycyclic aromatic hydrocarbons.** Leger, A.; Dhendecourt, L. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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The nature of the Very Small Grains evidenced by K. Sellgren (1985) is discussed. Their stability suggests that they are graphitic material and specifically polycyclic aromatic hydrocarbons (PAHs). The expected infrared emission of a typical PAH, coronene, gives an impressive spectroscopic agreement with the five observed Unidentified IR Emission Features, leading to an unambiguous identification. Those PAHs are the most abundant organic molecules detected to date (f is approximately .00001).

21357 (N—87-15043, pp vp) **Possible existence of interstellar polycyclic aromatic hydrocarbons (PAHs) in collected interplanetary dust particles.** Sandford, S.A. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Extraterrestrial dust particles which are 3 to 50 microns in size are routinely collected in the stratosphere and are now available for general laboratory study. These grains represent true Interplanetary Dust Particles (IDPs). Issues associated with the carbon containing components of IDPs which occur in a variety of physical forms, including amorphous mantles and matrix materials, are addressed. The observed properties of the hydrocarbon phase in IDPs are compared with those expected for polycyclic aromatic hydrocarbons (PAHs).

21358 (N—87-15043, pp vp) **More interstellar emission features at 3.3-3.6 micrometers!.** Tokunaga, A.T.; Nagata, T.; Sellgren, K.; Smith, R.G.; Onaka, T.; Nakada, Y.; Sakata, A.; Wada, S. (Tokyo Univ., Japan; Univ. of Electro-Communications, Tokyo, Japan). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Abstract Only.

The present data set consists of 3.20 to 3.55 micron spectra of HD44179, NGC 7027, BD+30 3639, and Elias 1 obtained with a cooled-grating array spectrometer (CGAS) at the NASA Infrared Telescope Facility. Emission features and details of the emission feature profiles are presented for high resolution spectra. Greater complexity is shown than might be expected. It is significant that the 3.29 micron feature has an invariant central wavelength, even at high resolution, and this strongly supports the case for a very specific substance or mixture of substances which is giving rise to this feature.

21359 (N—87-15043, pp vp) **Resolution of the 7.7 micrometers emission feature in NGC 7027.** Bregman, J.D.; Allamandola, L.J.; Tielens, A.G.G.M.; Witteborn, F.C.; Rank, D.M.; Wooden, D. (Lick Observatory, Santa Cruz, CA). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Abstract Only.

The unidentified infrared (UIR) features are a group of emission bands observed in a variety of objects, which can be characterized as having moderate density gas (densities from 1000 to 1,000,000/cu.cm.) and a nearby ultraviolet source. The origin of the features is still uncertain, but the current evidence points to polycyclic aromatic hydrocarbons (PAHs) as the source of the UIR features. Problems with identifying PAHs as the source of the UIR features are discussed.

21360 (N—87-15043, pp vp) **Spectroscopy and CCD-photography of extended red emission in reflection nebulae.** Witt, A.N.; Schild, R.E. (Harvard-Smithsonian Center for Astrophysics, Cambridge, MA). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Recent spectrographic studies of extended red emission (ERE) seen in the 0.6 to 0.9 micron spectral region in many reflection nebulae have shown fluorescence by amorphous hydrogenated carbon to be the most probable cause of the ERE. Spectrographic observations were performed on the nebulae NGC 2023 and NGC 7023, using the intensified Reticon scanner (IRS) of Kitt Peak National Observatory on the N0-2 0.9 mm telescope. Charge coupled device (CCD) images of NGC2023 and NGC 7023 were obtained with the CfA CCD detector on the 0.6 mm telescope of the Whipple Observatory. Results are discussed.

21361 (N—87-15043, pp vp) **IRAS surface brightness maps of visible reflection nebulae: evidence for non-equilibrium infrared emission.** Castelaz, M.W.; Werner, M.W.; Sellgren, K. (Hawaii Univ., Honolulu). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Abstract Only.

Surface brightness maps at 12, 25, 60, and 100 microns of 16 visible reflection nebulae were extracted from the Infrared Astronomy Satellite (IRAS) database. The maps were produced by coadding IRAS survey scans over areas centered on the illuminating stars, and have spatial resolutions of 0.9′ x 4′ at 12 and 25 microns, 1.8′ x 4.5′ at 60 microns, and 3.6′ x 5′ at 100 microns. Extended emission in the four IRAS bandpasses was detected in fourteen of the reflection nebulae. The IRAS data were used to measure the flux of the infrared emission associated with each source. The energy distributions show that the 12 micron flux is greater than the 25 micron flux in 11 of the nebulae, and the peak flux occurs in the 60 or 100 micron bandpass in all 16 nebular. The 60 and 100 micron flux can be approximated by blackbodies with temperatures between 30 and 50 K, consistent with temperatures expected from extrapolation of greybody fits to the 60 and 100 micron data. The

excess 12 and 25 micron emission is attributed to a nonequilibrium process such as emission from thermal fluctuations of very small grains excited by single ultraviolet photons, or emission from polycyclic aromatic hydrocarbons (PAHs) excited by ultraviolet radiation. The common features of the energy distributions of the 16 reflection nebulae, also seen in the reflection nebulae associated with the Pleiades, suggest that PAHs or very small grains may be found in most reflection nebulae.

21362 (N—87-15043, pp vp) **Infrared studies of supernova remnants with the IRAS.** Dwek, E.; Petre, R.; Szymkowiak, A. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Abstract Only.

A comparative study of the infrared and X-ray fluxes and morphologies of supernova remnants (SNR) can yield valuable information on their evolution and on their interaction with the ambient interstellar medium (ISM).

21363 (N—87-15043, pp vp) **Unusual relative strengths of the diffuse interstellar bands in some interstellar dust clouds.** Krelowski, J.; Walker, G.A.H. (British Columbia Univ., Vancouver). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Abstract Only.

Some of the diffuse interstellar features (DIBs) in the spectra of certain stars at high galactic latitudes (1 is greater than 15 degrees) are unusually weak or absent while others have the strength expected for their color excess. In some cases the stars are probably reddened by single interstellar clouds. There appear to be three families of DIBs. The effects of these families are examined. The existance of the three families implies that at least three agents cause the DIBs and that the proportions of the agents or the physical conditions giving rise to the DIBs can vary from cloud to cloud.

21364 (N—87-15043, pp vp) **Moderate spectral resolution observations of 3 micron absorption features in highly obscured objects.** Smith, R.G.; Sellgren, K.; Tokunaga, A.T. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

The 3 micron absorption spectra of sources seen in or behind molecular clouds generally show a variety of absorption features. Three separate absorptions are used to explain these features. The cooled-grating array spectrometer (CGAS) at the NASA Infrared Telescope Facility was used to obtain spectra of the late-type mass-loss star OH 0739-12 and the protostars MonR2 IRS-2 and IRS-3 (solid circles). The differences between the spectra are discussed.

21365 (N—87-15043, pp vp) **Some recent infrared spectroscopy of interstellar processes.** Geballe, T.R. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

The potential which infrared spectroscopic techniques provide for studying interstellar process is demonstrated. Several examples are given. The data were obtained at UKIRT, using its frequency-chopped Fabry-Perot spectrometer and its seven-channel cooled grating spectrometer.

21366 (N—87-15043, pp vp) **3.1 micrometer ice band in infrared reflection nebulae.** Pendleton, Y.; Werner, M.; Tielens, A.G.G.M. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Recent observations show that infrared reflection nebulae are common phenomena in star forming regions. Extensive observations were made of two nearby infrared reflection nebulae, Orin Molecular Cloud 2 IRS1 (OMC-2/IRS1) and Cepheus A IRS6a (Cep-A/IRS6a). Mie scattering models of ice coated grains were used to study the constraints on the properties and locations of grains that could produce a feature similar to that observed in OMC-2 and Cep-A. It was concluded that scattering by ice particles alone could not be responsible for the 3.1 micron feature observed in infrared reflection nebulae.

21367 (N—87-15043, pp vp) **Relationships between dust grain components responsible for observed interstellar extinction and polarization.** Clayton, G.C. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Ultraviolet extinction properties of interstellar dust are well observed. The amount of extinction measured in the visible (E(B-V)), at the 2200 A feature (E(BUMP)), and in the far ultraviolet (E(1550-V)) are only vaguely correlated indicating that at least 3 fairly independent populations of grains contribute to the overall extinction curve. A search of literature was made for polarimetric observations of the 1415 stars included in the extinction catalog derived from the Astronomical Netherlands Satellite (ANS) data. It was found that about 900 of the stars had at least one unfiltered polarimetric observation, p (%). In addition, 150 stars had calculated values of lambda sub max (wavelength at which maximum polarization occurs). The lambda sub max and p/E(B-V) parameters are discussed.

21368 (N—87-15043, pp vp) **Depletions and extinction curves for lines of sight through the outer edges of truly dense molecular clouds.** Joseph, C.L. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Observations of a few moderately reddened (0.3 is less than E(B-V) is less than 0.6) lines of sight through the outer edges of truly dense molecular clouds, not only show the overall depletions in these clouds to be as much as 0.5 (dex) greater than in comparably reddened diffuse clouds, but reveal a possible tendency for certain species to deplete preferentially. Possible methods of depletions are discussed.

21369 (N—87-15043, pp vp) **Shapes of the circumstellar silicate features.** Little-Marenin, I.R.; Price, S.D. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Around oxygen-rich stars the spectra of most long-period variables (LPV) show an excess infrared emission which is attributed to circumstellar silicate dust grains. It is known that the spectral energy distribution of the 10 micron emissions shows variations from star to star. With the availability of many Infrared Astronomy Satellite (IRAS) Low Resolution Spectra (LRS) in the 8 to 22 micron region, the 10 micron feature can be studied to determine its uniformity (or lack thereof). The excess silicate emissions (10 micron emission), divided into three groups characterized by similar spectral shapes, are discussed.

21370 (N—87-15043, pp vp) **Ultraviolet extinction in M-supergiant circumstellar envelopes.** Buss, R.H., Jr.; Snow, T.P., Jr. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Using International Ultraviolet (IUS) archival low-dispersion spectra, ultraviolet spectral extinctions were derived for the circumstellar envelopes of two M supergiants: HD 60414 and HD 213310. The observed stellar systems belong to a class of widely-separated spectroscopic binaries that are called VV Cephei stars. The total extinction was calculated by dividing the reddened fluxes with unreddened comparison fluxes of similar stars (g B2.5 for HD 213310 and a normalized s+B3 for HD 60414) from the reference atlas. After substracting the interstellar extinctions, which were estimated from the E(B-V) reddening of nearby stars, the resultant circumstellar extinctions were normalized at about 3.5 inverse microns. Not only is the 2175 A extinction bump absent in the circumstellar extinctions, but the far-ultraviolet extinction rise is also absent. The rather flat, ultraviolet extinction curves were interpreted as signatures of a population of noncarbonaceous, oxygen-rich grains with diameters larger than the longest observed wavelength.

21371 (N—87-15043, pp vp) **Spectral characteristics of dust in carbon rich objects.** Silverberg, R.F.; Moseley, H.; Glaccum, W. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Some carbon-rich objects exhibit a strong broad emission feature beginning at lambda is approximately 24 microns and extending to lambda is greater than 30 microns. A 20 to 65 microm spectrum of the carbon star IRC+10216 and 30 to 50 micron spectra of three carbon-rich planetary nebulae, IC 418, NGC 6572, and BD+30 degrees 3639 are presented. The strong emission feature around 30 microns is seen clearly in IRC+10216, IC 418, and NGC 6572. The role of silicon carbides and magnesium sulfur particles in this feature is discussed.

21372 (N—87-15043, pp vp) **Organic component of interstellar grains.** Schutte, W.A.; Greenberg, J.M. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

The 3.4 micron absorption feature observed in the spectrum of a number of Galactic Center (GC) sources indicates the presence of organic molecules in the interstellar medium. It is ascribed to the C-H stretch vibration of tetrahedrally bonded carbon. From the observed features due to the interstellar organic material, an estimate was made of its composition and abundance. The ratio of the number of C-H groups of tetrahedrally to those of trigonally bonded carbon was 1.5, the cosmic abundance of carbon was .00037, and the depth of the silicate absorption toward the GC was taken equal to 3.6.

21373 (N—87-15043, pp vp) **Measuring interstellar grains from the haloes of binary X-ray sources.** Xu, Y.; Mccray, R. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Coherent forward scattering of x-rays by interstellar grains creates a halo around the x-ray image of a compact source. The fractional halo brightness at 2 keV is typically of order 10% moderately reddened galactic sources. The angular brightness distribution of the halo, which extends over several arcminutes, indicates the size distribution of the grains, and the spectrum of the halo indicates the composition of the grains. The halo will persist for several hours after the point source vanishes during an eclipse of a binary source; this provides a way to avoid systematic errors in measuring halo brightness due to an extended point response function of the x-ray telescope. Indeed, it is possilbe to infer the size distribution and composition of the grains without an imaging x-ray telescope by observing the time-dependence of the halo spectrum during eclipse.

21374 (N—87-15043, pp vp) **Molecular catastrophes and the formation of circumstellar dust.** Stencel, R.E. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Interstellar dust grains are presumed in part to have their origins in the outer atmospheres of red giant and supergiant stars because, despite the efficiency of shock destruction of grains in the interstellar medium (ISM), meteoritic samples possess isotopic signatures that are consistent with nucleosynthetic origin in the interior of evolved stars. There is ample evidence to suggest that once dust grains form near red giants and supergiants, radiation pressure is sufficient to drive them to infinity. The molecular catastrophe description for the conversion of chromospheric gas into molecular masers and circumstellar dust holds promise for a coherent explanation of the formation of these entities and the process of mas loss from cool, high luminosity objects.

21375 (N—87-15043, pp vp) **Translucent molecular clouds: theory and observations.** Vandishoeck, E.F.; Black, J.H. (Arizona Univ., Tucson). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Few suitable stars behind molecular clouds have been identified. A limited survey was performed of interstellar lines toward highly reddened stars in the southern sky, using the ESO 1.4 m CAT telescope with a Reticon detector, and the Cerro Tololo 4 m telescope equipped with a GEC charge coupled device (CCD) detector. Because of the reduced extinction at longer wavelengths, molecules were searched for with transitions in the red part of the spectrum such as $C_2$ and CN. For some lines-of-sight for which $C_2$ was detected, the 4300 A line of CH was also observed. Absorption lines of interstellar $C_2$ around 8750 A were detected in the spectra of about 1/4 of the 36 observed stars. The inferred $C_2$ column densities range between 10 to the 13th power and 10 to the 14th power sq. cm., and are up to an order of magnitude larger than those found for diffuse clouds. The observed column densities of CH correlate very well with those of $C_2$ over this range. In contrast, the measured column densities of CN vary by orders of magnitude between the various regions, and they do not correlate with those of $C_2$ and CH. The observed rotational population distribution of $C_2$ also provides information about the physical conditions in the clouds. Models of translucent molecular clouds have been constructed along the lines described by van Dishoeck and Black (1986) for diffuse clouds. The models compute accurately the fractions of atomic and molecular hydrogen as functions of depth into the clouds, as well as the excitation of H2 by ultraviolet pumping. They also incorporate a detailed treatment of the photodissociation processes of the molecules (cf. van Dishoeck 1986), which play an important role in the chemistry up to depths of about 3 mag.

21376 (N—87-15043, pp vp) **Large rate coefficients for ion-polar neutral reactions have a serious effect on chemical models of dense clouds?.** Herbst, E.; Leung, C.M. (Rensselaer Polytechnic Institute, Troy, NY). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

In order to incorporate large ion-polar neutral rate coefficients into existing gas phase reaction networks, it is necessary to utilize simplified theoretical treatments because of the significant number of rate coefficients needed. The authors have used two simple theoretical treatments: the locked dipole approach of Moran and Hamill for linear polar neutrals and the trajectory scaling approach of Su and Chesnavich for nonlinear polar neutrals. The former approach is suitable for linear species because in the interstellar medium these are rotationally relaxed to a large extent and the incoming charged reactants can lock their dipoles into the lowest energy configuration. The latter approach is a better ap-

proximation for nonlinear neutral species, in which rotational relaxation is normally less severe and the incoming charged reactants are not as effective at locking the dipoles. The treatments are in reasonable agreement with more detailed long range theories and predict an inverse square root dependence on kinetic temperature for the rate coefficient. Compared with the locked dipole method, the trajectory scaling approach results in rate coefficients smaller by a factor of approximately 2.5.

21377 (N—87-15043, pp vp) **Studies of interstellar vibrationally-excited molecules.** Ziurys, L.M.; Snell, R.L.; Erickson, N.R. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Several molecules thus far have been detected in the ISM in vibrationally-excited states, including $H_2$, SiO, $HC_3N$, and $CH_3CN$. In order for vibrational-excitation to occur, these species must be present in unusually hot and dense gas and/or where strong infrared radiation is present. In order to do a more thorough investigation of vibrational excitation in the interstellar medium (ISM), studies were done of several mm-wave transitions originating in excited vibrational modes of HCN, an abundant interstellar molecule. Vibrationally-excited HCN was recently detected toward Orion-KL and IRC+10216, using a 12 meter antenna. The J=3-2 rotational transitions were detected in the molecule's lowest vibrational state, the bending mode, which is split into two separate levels, due to l-type doubling. This bending mode lies 1025K above ground state, with an Einstein A coefficient of 3.6/s. The J=3-2 line mode of HCN, which lies 2050K above ground state, was also observed toward IRC+10216, and subsequently in Orion-KL. Further measurements of vibrationally-excited HCN were done using a 14 meter telescope, which include the observations of the (0,1,0) and (0,2,0) modes towards Orion-KL, via their J=3-2 transitions at 265-267 GHz. The spectrum of the J=3-2 line in Orion taken with the 14 meter telescope, is shown, along with a map, which indicates that emission from vibrationally-excited HCN arises from a region probably smaller than the 14 meter telescope's 20 arcsec beam.

21378 (N—87-15043, pp vp) **Multi-level study of $C_3H_2$: the first interstellar hydrocarbon ring.** Madden, S.C.; Irvine, W.M.; Matthews, H.E.; Avery, L.W. (Herzberg Institute of Astronomy, Ottawa, Ontario). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Cyclic species in the interstellar medium have been searched for almost since the first detection of interstellar polyatomic molecules. Eleven different $C_3H_2$ rotational transitions were detected; 9 of which were studied in TMC-1, a nearby dark dust cloud, are shown. The 1 sub 10 yields 1 sub 01 and 2 sub 20 yields 2 sub 11 transitions were observed with the 43 m NRAO telescope, while the remaining transitions were detected with the 14 m antenna of the Five College Radio Observatory (FCRAO). The lines detected in TMC-1 have energies above the ground state ranging from 0.9 to 17.1 K and consist of both ortho and para species. Limited maps were made along the ridge for several of the transitions. The $HC_3N$ J = 2 yields 1 transition were mapped simultaneously with the $C_3H_2$ 1 sub 10 yields 1 sub 01 line and therefore can compare the distribution of this ring with a carbon chain in TMC-1. $C_3H_2$ is distributed along a narrow ridge with a SE - NW extension which is slightly more extended than the HC2N J = 2 yields 1. Gaussian fits gives a FWHP extension of 8'5 for $C_3H_2$ while $HC_3N$ has a FWHP of 7'. The data show variations of the two velocity components along the ridge as a function of transition. Most of the transitions show a peak at the position of strongest $HC_3N$ emission while the 2 sub 21 yields 2 sub 10 transition shows a peak at the $NH_3$ position.

21379 (N—87-15043, pp vp) **Effects of stellar outflows on interstellar sulfur oxide chemistry.** Welch, W.J.; Vogel, S.; Terebey, S.; Dreher, J.; Jackson, J.; Carlstrom, J. (California Institute of Technology, Pasadena; Massachusetts Institute of Technology, Cambridge). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Interferometer Maps with 2" to 6" resolution of a number of regions with active star formation (Orion A, W49, W51, SGRB2) show that the distribution of the molecule SO is very compact around stellar outflow sources. Both SO and $SO_2$ were studied near three outflows, OrionA/IRc2 and two sources in W49. The two molecules have similar distributions and abundances. More than 95% of the emission comes from regions whose extents are only .05 to .2 pc., being larger around the more energetic sources. Their spectra are broad, 30 km/sec or more, suggesting that the oxide production is associated with the flows. The outflows are identified by water masers and by extended bipolar flows in SiO. Maps in other molecules, such as HCO+ and CS, which have similar collisional excitation requirements, have much greater spatial extent. Thus it appears that the SO and $SO_2$ abundances are truly compact and are closely associated with the outflows.

21380 (N—87-15043, pp vp) **Interstellar absorption lines in the spectrum of sigma Sco using Copernicus observations.** Allen, M.M.; Snow, T.P. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Since the launch of Copernicus in 1972, studies have been made of the depletion of gas-phase elements onto dust grains. A few stars have been studied in detail, resulting in a standard depletion pattern which has since been used for comparison. Recent developments, however, have suggested that this standard pattern may need to be re-examined. Some weak, semi-forbidden lines were detected recently which may be able to resolve some of the ambiguities. Studies of single elements have shown that depletion of carbon and oxgyen are much smaller than previously determined. The high resolution ultraviolet spectral scans of sigma Sco were originally made in 1973, but have only recently been analyzed. All these stars are bright and moderately reddened. All four stars will be analyzed in detail, but sigma Sco is the first one completed. The data has broad coverage of ions, making these stars excellent candidates for determination of accurate depletions. A profile-fitting analysis was used rather than curves-of-growth in order to determine separate abundances and depletions in components separated by several km/sec.

21381 (N—87-15043, pp vp) **Abundance of interstellar sulphur and zinc in high density sight-lines.** Harris, A.W.; Mashesse, J.M. (Universidad Complutense, Madrid, Spain). Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Detailed studies are reported of the depletion/density behavior of two volatile elements previously considered to be virtually undepleted, S and Zn, using equivalent width data from both Copernicus and IUE observations. The results provide further evidence that the established dependence of depletion on n bar (H) extends to volatile elements and show that their use as tracers of metallicity, or for estimating hydrogen column densities, may lead to large errors in sight-lines through dense regions. It now appears that such elements may take part in the surface chemistry of grains and be important constituents of grain mantle material, although they probably do not contribute significantly to the bulk mass of grains. Due to the very similar atomic masses and ionization potentials of sulphur and phosphorous, the thermal velocity distributions of the singly ionized species of these elements in interstellar clouds should be very similar. However, a comparison of Doppler widths

(b-values) derived for SIT and PIT in the same sight-lines from the Bohlin et al Copernicus equivalent width measurements has revealed an unexpected systematic discrepancy of a factor of approx. 1.7. This discrepancy indicates that the normally adopted oscillators strengths of the PII lambda lambda 1153 and 1302 A lines may require revision.

21382 (N—87-15043, pp vp) **IUE/IRAS studies of metal abundances and infrared cirrus.** Vansteenberg, M.E.; Shull, J.M. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

A survey is reported of interstellar densities, abundances, and cloud structure in the Galaxy, using the IUE and IRAS satellites. Heavy element depletions are discussed along with their correlations with mean density, reddening, and galactic location. Interesting correlations between the Fe/Si abundance ratio and the infrared diffuse cirrus is also reported, which may provide information on the history and formation of grains in the galactic halo.

21383 (N—87-15043, pp vp) **Fragmented molecular complexes: the role of the magnetic field in feeding internal supersonic motions.** Falgarone, E.; Puget, J.L.; Perault, M. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

A hierarchical structure for molecular complexes in their cold phase, i.e., preceeding the formation of massive stars, was derived from extensive large scale CO(13)(J=1=0) observations: the mass is found to be distributed into virialized clouds which fill only a very low fraction approx. 01 of the volume of the complex and are supported against gravity by internal supersonic motions. An efficient mechanism was found to transfer kinetic energy from the orbital motions of the clouds to their internal random motions. The large perturbations of the magnetic field induced at the cloud boundaries by their interactions with their neighbors generate systems of hydromagnetic waves trapped inside the clouds. The magnetic field lines being closely coupled to the gas at the densities which prevail in the bulk of the clouds volume, internal velocity dispersion is thus generated. Some conclusions derived from this data are given.

21384 (N—87-15043, pp vp) **Interpretation of the beta(sub p) relation in interstellar clouds.** Koenigl, A. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

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Abstract Only.

Troland and Heiles (1986) have recently presented an updated compilation of observational data concerning the relationship between the interstellar magnetic field strength B and the gas density rho (or, equivalently, the particle density n). One of the main findings of their survey was that B remains constant over the density range 0.1 - approx. 100 cu. cm and shows evidence for increase only a higher densities. They compared this result with theoretical predictions based on the Parker-instability scenario for the formation and evolution of interstellar clouds in the presence of the galactic magnetic field. In this picture, low-density gas is driven by the magnetic Rayleigh-Taylor instability into magnetic valleys, where it accumulates into denser concentrations. The gas initially flows along the magnetic field lines and there is little increase of the field strength with density; B only starts to rise when n becomes large enough for self-gravity to begin competing with the magnetic stresses. For a cloud mass of approx. 1000 sub M and the measured background field strength, the critical density for contraction in approx. 75 cu. cm. Troland and Heiles therefore concluded that this scenario is basically consistent with the observations. This conclusion is debated.

21385 (N—87-15043, pp vp) **Magnetic field in molecular cloud cores: limits on field strengths and linewidths.** Goodman, A.A. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Abstract Only.

Preliminary observations by others indicate that the magnetic field strength in dense molecular cloud cores is on the order of 30 micro G, much closer to the background field strength than to the flux-freezing prediction for this density. This result implies that some process must exist to decrease the magnetic field strength in these regions to much less than its flux-frozen value, e.g., ambipolar diffusion. At these moderate field strengths, magnetohydrodynamic waves in the cores provide a good explanation of observed suprathermal molecular linewidths.

21386 (N—87-15043, pp vp) **Models for application of radiation boundary condition for MHD waves in collapse calculations.** Vanajakshi, C.T.; Scott, E.H.; Black, D.C. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Abstract Only.

The problem of reflection of magnetohydrodynamic (MHD) waves at the boundary of a numerical grid has to be resolved in order to obtain reliable results for the end state of the (isothermal) collapse of a rotating, magnetic protostellar cloud. Since the goal of investigating magnetic braking in collapse simulations is to see if the transport of angular momentum via alfven waves is large enough to solve the angular momentum problem an approximation that artificially suppresses large amplitudes in the MHD waves can be self-defeating. For this reason, four alternate methods of handling reflected waves where no assumptions are made regarding the amplitudes of the waves were investigated. In order to study this problem (of reflection) without interference from other effects these methods were tried on two simpler cases. The four methods are discussed.

21387 (N—87-15043, pp vp) **Magnetic braking in weakly ionized circumstellar disks.** Koenigl, A. Oct 1986. NTIS, PC A10/MF A01. (NASA-TM—88342; A—86393; NAS—1.15:88342; CONF-8607112—Absts.).

From Interstellar processes conference; Jackson, WY, USA (3 Jul 1986).

Abstract Only.

Recent observations of disk-like mass distributions around newly formed stars have provided evidence for rapid rotation on scales similar to less than 0.1pc with specific angular momenta much higher than typical stellar values. A likely mechanism for the extraction of angular momentum from these regions is magnetic braking by means of Alfven waves that propagate into the lower-density ambient medium. However, because of the relatively high particle densities and the correspondingly low implied ionization fractions in these apparent disks, their constituent ions and neutrals need not be well coupled to each other and could develop large relative drift velocities. For this reason, previous treatments of magnetic braking that assumed perfect coupling between ions and neutrals have to be modified in this case. In particular, one has to take into account both the azimuthal drift that develops because only the ions are directly coupled to the magnetic field and the radial drift (or ambipolar diffusion) which leads to a redistribution (and leakage) of the magnetic flux. The results of a preliminary analysis of these effects are described.

21388 (N—87-15136) **Double layers and circuits in astrophysics.** Alfven, H. (Royal Inst. of Tech., Stockholm (Sweden)). May 1986. 61p. (NASA-CR—180018; NAS—1.26:180018; TRITA-EPP—86-04; ETN—86-98325). NTIS, PC A04/MF A01.

From Double Layers in Astrophysics Symposium; Huntsville, AL, USA (17 Mar 1986).

A simple circuit is applied to the energizing of auroral particles, to solar flares, and to intergalactic double radio sources. Ap-

plication to the heliospheric current systems leads to the prediction of two double layers on the Sun's axis which may give radiations detectable from Earth. Double layers in space should be classified as a new type of celestial object. It is suggested that x-ray and gamma-ray bursts may be due to exploding double layers (although annihilation is an alternative energy source). The way the most used textbooks in astrophysics treat concepts like double layers, critical velocity, pinch effects and circuits was studied. It is found that students using these textbooks remain essentially ignorant of even the existence of these, although some of the phenomena were discovered 50 yr ago.

21389 **(PB—87-126389/XAB) Solar-Geophysical Data Number 506, October 1986. Part 1 (prompt reports). Data for September 1986, August 1986, and late data.** Coffey, H.E. (National Geophysical Data Center, Boulder, CO (USA)). Oct 1986. 102p. (SGD—506-PT-1). NTIS, PC A06/MF A01.

See also PB—87-107595 and PB—87-126397.

Contents include: Detailed index for 1986; Data for September 1986--(IUWDS alert periods (advance and worldwide), Solar activity indices, Solar flares, Solar radio emission, Stanford mean solar magnetic field); Data for August 1986--(Solar active regions, Sudden ionospheric disturbances, Solar radio spectral observations, Cosmic-ray measurements by neutron monitor, Geomagnetic indices, Radio propagation indices); Late data--(Solar radio emission August 1986, Solar active regions July 1986, Cosmic-ray measurements by neutron monitor, Calcium plage data December 1985-February 1986).

21390 **(PB—87-126397/XAB) Solar-Geophysical Data Number 506, October 1986. Part 2 (comprehensive reports). Data for April 1986.** Coffey, H.E. (National Geophysical Data Center, Boulder, CO (USA)). Apr 1986. 34p. (SGD—506-PT-2). NTIS, PC A03/MF A01.

See also PB—87-126389 and PB—87-107603.

Contents include: Detailed index for 1986; Data for April 1986--(Meudon carte synoptique, Solar flares, Solar radio bursts at fixed frequencies, Solar x-ray radiation from GOES satellite, Mass ejections from the sun, and Active prominences and filaments).

21391 **(PB—87-127643/XAB) Low-frequency VLBI in space and interstellar refraction.** Dennison, B.; Booth, R.S. (Chalmers Univ. of Tech., Goeteborg (Sweden). Onsala Space Observatory). Aug 1986. 13p. (REPT—86/46). NTIS, PC PC E03/MF E01.

The proposed orbiting Quasat antenna, equipped with a low-frequency capability (e.g. 327 MHz), would be uniquely suited for studying refractive focusing (slow scintillation) in the interstellar medium, which is suspected of being responsible for at least some apparent low-frequency variability of extragalactic sources. The authors consider in some detail various technical considerations, including the decorrelating effects of the ionosphere and interplanetary medium, and conclude that low-frequency VLBI observations involving Quasat and Earth-based antennas would be feasible, particularly if sources are observed when they are in the anti-solar hemisphere.

21392 **(SLAC-PUB—4151) Recent results from the Crystal Ball experiment.** Lowe, S.T. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Dec 1986. Contract AC03-76SF00515. 13p. (CONF-860736—8). NTIS, PC A02. File Number DE87005957.

From SLAC summer institute on particle physics; Stanford, CA, USA (29 Jul 1986).

Several recent analyses from the Crystal Ball collaboration are reviewed. The major topics discussed are the search for new states in radiative Y(1S) decays, the search for lepton number-violating and inclusive eta decay modes of the tau, and results from $\gamma\gamma$ physics.

21393 **Double inflation.** Silk, J.; Turner, M.S. (Astronomy Department, University of California at Berkeley, Berkeley, California 94720). *Physical Review [Section] D: Particles and Fields;* **35**: No. 2, 419-428(15 Jan 1987).

The Zel'dovich spectrum of adiabatic density perturbations is a generic prediction of inflation. There is increasing evidence that when the spectrum is normalized by observational data on small scales, there is not enough power on large scales to account for the observed large-scale structure in the Universe. Decoupling the spectrum on large and small scales could solve this problem. As a means of decoupling the large and small scales we propose double inflation (i.e., two episodes of inflation). In this scenario the spectrum on large scales is determined by the first episode of inflation and those on small scales by a second episode of inflation. We present three models for such a scenario. By nearly saturating the large-angular-scale cosmic microwave anisotropy bound, we can easily account for the observed large-scale structure. We take the perturbations on small scales to be very large, deltarho/rho≃0.1—0.01, which results in the production of primordial black holes, early formation of structure, reionization of the Universe, and a rich array of astrophysical events. The $\Omega$ problem is also addressed by our scenario. Allowing the density perturbations produced by the second episode of inflation to be large also lessens the fine-tuning required in the scalar potential and makes reheating much easier. We briefly speculate on the possibility that the second episode of inflation proceeds through the nucleation of bubbles, which today manifest themselves as empty bubbles whose surfaces are covered with galaxies.

21394 **Luminous axion clusters.** Kephart, T.W.; Weiler, T.J. (Department of Physics and Astronomy, Vanderbilt University, Nashville, Tennessee 37235). *Physical Review Letters;* **58**: No. 2, 171-173(12 Jan 1987).

Density fluctuations of axionic dark matter decaying to photons are shown to have possibly measurable luminosities.

21395 **Chemical and physical studies of type 3 chondrites - VI: siderophile elements in ordinary chondrites.** Sears, D.W.G.; Weeks, K.S. (Univ. of Arkansas, Fayetteville). *Geochimica et Cosmochimica Acta;* **50**: No. 12, 2815-2832(Dec 1986). Contract FG02-80ER10725.

The abundances of Fe, Ni, Co, Au, Ir, Ga, As and Mg have been determined by instrumental neutron activation analysis in 38 type 3 ordinary chondrites (10 of which may be paired) and 15 equilibrated chondrites. Classification of type 3 ordinary chondrites into the H, L and LL classes using oxygen isotopes and parameters which reflect oxidation state (Fa and Fs in the olivine and pyroxene, and Co in kamacite) is difficult or impossible. Bulk compositional parameters, based on the equilibrated chondrites, have therefore been used to classify the type 3 chondrites. The distribution of the type 3 ordinary chondrites over the classes is very different from that of the equilibrated chondrites, the LL chondrites being more heavily represented. The type 3 ordinary chondrites contain 5 to 15% lower abundances of siderophile elements, and a compilation of the present data and literature data indicates a small, systematic decrease in siderophile element concentration with decreasing petrologic type. The type 3 ordinary chondrites have, like the equilibrated ordinary chondrites, suffered a fractionation of their siderophile elements, but the loss of Ni in comparison with Au and Ir is greater for the type 3 chondrites. These siderophile element trends were established at the nebula phase of chondritic history and the co-variation with petrologic type implies onion-shell structures for the ordinary chondrite parent bodies. It is also clear that the relationship between the type 3 and the equilibrated ordinary chondrites involves more than simple, closed-system metamorphism.

21396 **Physical properties of shocked and thermally altered nontronite: Implications for the Martian surface.** Boslough, M.B.; Venturini, E.L.; Morosin, B.; Graham, R.A.; Williamson, D.L. (Sandia National Laboratories, Albuquerque, New Mexico). *Journal of Geophysical Research;* **91**: No. B13, E207-E214(30 Nov 1986).

Both shock recovery and thermal annealing experiments have been carried out on Riverside nontronite, an iron-rich smectite clay that closely matches the composition, but neither the color nor magnetic properties, of the Martian fines. Nontronite was recovered from peak shock pressures between 7 and 32 GPa, with calculated peak mean bulk temperatures ranging from 125° to 1100° C. Other nontronite samples were heated in air for one hour at temperatures ranging from 400° to 1000° C at 100° C increments. Both

shocked and heat-treated samples were analyzed by magnetic measurements, X ray diffraction, and Moessbauer spectroscopy. Nontronite powders shock-loaded to peak calculated temperature of 650° C to 750° C show a dramatic increase in ferromagnetic saturation magnetization (M/sub s/). A similar increase in magnetization in the same temperature range is observed in isothermally annealed powders at atmospheric pressure. The X ray diffraction and Moessbauer studies show, however, that for samples that experienced temperatures of 600° C or more, the shocked material has little structural similarity to the isothermally annealed nontronite. This suggests that the ferromagnetic properties may be due to a minor phase. There is evicence from Moessbauer spectra for metallic iron in the shocked samples and for superparamagnetic $Fe_2O_3$ in the annealed samples. In addition to magnetic and structural changes, the shock and heating experiments altered the color of the nontronite from olive-yellow toward reddish-brown, yielding material that matches the observed properties of the Martian fines much more closely than the starting material does.

21397 **Simulations of collisionless shocks.** Quest, K.B. (Los Alamos National Laboratory, Los Alamos, NM 87544). *AIP (American Institute of Physics) Conference Proceedings;* **144**: No. 1, 342-348(30 Jun 1986). (CONF-8408121—).

From Los Alamos workshop on magnetospheric phenomena in astrophysics; Taos, NM, USA (6 Aug 1984).

A problem of critical importance to space and astrophysics is the existence and properties of high-Mach-number (HMN) shocks. In this letter we present the results of simulations of perpendicular shocks with Alfven Mach number 22. We show that the shock structure is a sensitive function of resistivity, becoming turbulent when the resistivity is too low. We discuss the problem of electron heating, and the extension of our results to higher Mach numbers.

21398 **Oscillatory instability of interstellar medium radiative shock waves.** Imamura, J.N. (Los Alamos National Laboratory, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **144**: No. 1, 242-249(30 Jun 1986). (CONF-8408121—).

From Los Alamos workshop on magnetospheric phenomena in astrophysics; Taos, NM, USA (6 Aug 1984).

Observations of the radiative shock waves produced during the late stages of supernova remnant evolution cannot be understood in the context of steady shock models. As a result, several more complicated scenarios have been suggested. For example, it has been proposed that several shocks are producing the emission or that one shock, which is in the process of making the transition between the adiabatic and the radiative phases of its evolution, produces the emission. In this paper, we suggest another explanation. We propose that supernova remnant shock waves are subject to an oscillatory instability. By an oscillatory instability, we mean one where the postshock cooling region periodically varies in size on a time scale determined by the postshock plasma cooling time. An oscillatory instability may be able to produce the types of behavior exhibited by supernova remnant radiative shocks in a natural way.

21399 **Winds in cataclysmic variable stars.** Cordova, F.A.; Ladd, E.F.; Mason, K.O. (Los Alamos National Laboratory, M.S. D436, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **144**: No. 1, 250-262(30 Jun 1986). (CONF-8408121—).

From Los Alamos workshop on magnetospheric phenomena in astrophysics; Taos, NM, USA (6 Aug 1984).

Ultraviolet spectrophotometry of two dwarf novae, CN Ori and RX And, at various phases of their outburst cycles, confirms that the far UV flux increases dramatically about 1—2 days after the optical outburst begins. At this time the UV spectral line profiles indicate the presence of a high velocity wind. The detectability of the wind depends more on the steepness of the spectrum, and thus on the flux in the extreme ultraviolet, than on the value of the far UV luminosity. The UV continuum during outburst consists of (at least) two components, the most luminous of which is located behind the wind and is completely absorbed by the wind at the line frequencies. Several pieces of evidence suggest that the UV emission lines that are observed in many cataclysmic variables during quiescence originate in a location different from that of the wind in the binary, and are affected little by the outburst.

21400 **Theory of axisymmetric magneto-hydrodynamic flows.** Lovelace, R.V.E.; Mehanian, C.; Mobarry, C.M.; Sulkanen, M.E. (Department of Astronomy and Department of Applied Physics, Cornell University, Ithaca, N.Y. 14853). *AIP (American Institute of Physics) Conference Proceedings;* **144**: No. 1, 291-312(30 Jun 1986). (CONF-8408121—).

From Los Alamos workshop on magnetospheric phenomena in astrophysics; Taos, NM, USA (6 Aug 1984).

A derivation from the weak-gravity limit of general relativity is given of the basic equation for the flux function psi(r,z) for general, steady, axisymmetric, relativistic, ideal magneto-hydrodynamic flows aroud a black hole or a rotating magnetized star. One limit of this equation gives the Grad-Shafranov equation, which describes the equilibrium of axisymmetric fusion plasmas. Another limit gives, except for an additional term, the 'pulsar equation' of Scharlemann, Wagoner, and Michel for relativistic plasma flows around an aligned, rotating, magnetized neutron star.

21401 **Global aspects of stream evolution in the solar wind.** Gosling, J.T. (University of California, Los Alamos National Laboratory, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **144**: No. 1, 124-144(30 Jun 1986). (CONF-8408121—).

From Los Alamos workshop on magnetospheric phenomena in astrophysics; Taos, NM, USA (6 Aug 1984).

A spatially variable coronal expansion, when coupled with solar rotation, leads to the formation of high speed solar wind streams which evolve considerably with increasing heliocentric distance. Initially the streams steepen for simple kinematic reasons, but this steepening is resisted by pressure forces, leading eventually to the formation of forward-reverse shock pairs in the distant heliosphere. The basic physical processes responsible for stream steepening and evolution are explored and model calculations are compared with actual spacecraft observations of the process. Solar wind stream evolution is relatively well understood both observationally and theoretically. Tools developed in achieving this understanding should be applicable to other astrophysical systems where a spatially or temporally variable outflow is associated with a rotating object.

21402 **Cosmology and particle physics - a general review.** Olive, K.A. (Technion - Israel Institute of Technology, Haifa). *Annals of the New York Academy of Sciences;* **470**: 1-25(1986). (CONF-841238—).

From 12. Texas symposium of relativistic astrophysics; Jerusalem, Israel (17 Dec 1984).

The various stages in the evolution of the universe from approximately 0.0001 sec to approximately more than 100,000 years are discussed. The use of quantum gravity, the Kaluza (1921) and Klein (1926) theories, and supersymmetry to study the gravitational interactions during the Planck epoch is examined. Examples of the effect of exponential expansion due to a supercooled phase transition (inflation) are presented. The big bang baryosynthesis and nucleosynthesis hypotheses are reviewed. 86 references.

21403 **Ion reflection, gyration, and dissipation at supercritical shocks.** Gosling, J.T.; Robson, A.E. (Los Alamos National Lab., NM). pp 141-152 of Collisionless shocks in the heliosphere. Washington, DC; American Geophysical Union (1985).

Above a certain critical Mach number, M/sub c/, a collisionless shock reflects a fraction of the incoming ions. These reflected ions provide an important portion of the dissipation required to satisfy the Rankine-Hugoniot conservation laws at the shock. Ion reflection at a collisionless shock is nearly specular in nature, and an ion's magnetic moment is, in general, not conserved during the reflection process. The trajectory of a reflected ion is controlled by theta/sub Bn/, the angle between the upstream B and the local shock normal. This paper reviews laboratory and space measurements of reflected ions at supercritical shocks in different theta/sub Bn/ geometries, and attempts to provide a conceptual framework for understanding the important role these ions play in producing essential dissipation. 45 references, 12 figures.

## 6402 Atmospheric Physics

*REFER ALSO TO CITATION(S) 21047, 21389, 21487, 21948*

**21404 (AD-A—175151/0/XAB) Electron cyclotron harmonic waves observed by the AMPTE-IRM (active magnetospheric particle tracer explorers-ion release module) plasma wave experiment following a lithium release in the solar wind. Technical report.** Roeder, J.L.; Koons, H.C.; Holzworth, R.H.; Anderson, R.R.; Gurnett, D.A. (Aerospace Corp., El Segundo, CA (USA). Space Sciences Lab.). 1 Nov 1986. 34p. (TR—0086(6940-06)-4). NTIS, PC A03/MF A01.

An unexpected occurrence following the second lithium release by the AMTPE-IRM spacecraft in the solar wind was the appearance of electrostatic electron harmonic (ECH) emissions. These emissions began about 50 sec after the release and continued for several minutes. Narrow-band emissions polarized perpendicular to the magnetic field were present in each of the first five harmonic bands. Unpolarized broadhand emissions were also present at the same time. The broadhand emissions extended from below the electron-cyclotron frequency to above the highest ECH band. Both emissions were entirely electrostatic because no accompanying signals were detected by the magnetic antenna. Candidate generation processes include the ion acoustic and the electron-cyclotron drift instabilities. These instabilites would be driven by the relative drift of the lithium ions and the solar-wind electrons. It is shown that the calculated growth rates of these processes are sufficient to account for the measured waves, but that the observed lack of a Doppler shift of the ECH bands is inconsistent with the theory.

**21405 (AD-A—175153/6/XAB) Maximum-entropy technique for deconvolution of atmospheric bremsstrahlung spectra. Technical report.** Gorney, D.J.; Mizera, P.F.; Roeder, J.L. (Aerospace Corp., El Segundo, CA (USA). Space Sciences Lab.). 15 Oct 1986. 50p. (TR—0086A(2940-06)-1). NTIS, PC A03/MF A01.

Spectral parameters of auroral electrons incident on the atmosphere can be inferred from satellite observations of bremsstrahlung x-ray spectra. Although the production and transport of >1-keV bremsstrahlung x-rays in the atmosphere are reasonably well understood, in practice the use of bremsstrahlung measurements to infer incident electron spectra is hampered by instrumental limitations and low signal-to-noise ratio. Thus, a spectral deconvolution scheme that makes the most-effective use of available data is required. The maximum entropy formalism is a statistical technique which provides a statistically optimal estimator of a continuous quantity (in this case, the electron spectrum) when a discrete set of integral functions of that quantity are known (namely, the observed x-ray spectrum). A numerical maximum-entropy deconvolution scheme was developed and applied to bremsstrahlung x-ray measurements from the Aerospace x-ray spectrometer on DMSP-F6. Good results were obtained for inferred electron spectra acquired from a variety of auroral forms. These results are presented, and the stability and uniqueness of the solutions are discussed.

**21406 (AD-A—175170/0/XAB) Multiple-satellite observation of the high-latitude auroral activity on 11 January 1983. Technical report.** Gorney, D.J.; Mizera, P.F.; Evans, D.S.; Gussenhoven, M.S. (Aerospace Corp., El Segundo, CA (USA). Space Sciences Lab.). 1 Nov 1986. 34p. (TR—0086(6940-05)-15). NTIS, PC A03/MF A01.

Unusual high-latitude auroral activity occurred during a period of persistent IMF Bz > 0, and Bx . 0. This activity was characterized by numerous high-latitude sun-aligned arcs and a diffuse oval. A single broad (250 km) sun-aligned arc was observed by the optical linescan system on DMSP-F6. The arc was contiguous with the drawn auroral oval and extended across the northern polar cap, similar to previously reported theta aurora configurations. The fortunate orbital locations of the DMSP-F6, NOAA-7 and NOAA-6 satellites allows a detailed analysis of the precipitating-particle populations responsible for both the sun-aligned arc and oval auroras. Specifically, NOAA-7 and DMSP-F6 cross the broad sun aligned arc almost simultaneously in the northern hemisphere, with NOAA-7 crossing the arc 1500 km farther toward the dayside. During the arc crossing, NOAA-7 observes electron fluxes, temperatures and accelerations similar to DMSP-F6, but observes ion fluxes diminished by a factor of fifty in comparison with DMSP. Almost simultaneously NOAA-6 crosses the southern polar cap and observes flux levels in an apparent high latitude arc comparable to those observed by DMSP. The results are consistent with, but supplementary to, previous observations of high latitude auroral observations and thus place meaningful constraints on emerging theoretical concepts of this phenomenon.

**21407 (AD-A—175174/2/XAB) Development of techniques for the use of DMSP (Defense Meteorological Satellite Program) SSIE (Topside Ionospheric Plasma Monitor) data in the AWS (Air Weather Service) 4d ionosphere model. Technical report.** Secan, J.A. (Physical Dynamics, Inc., Bellevue, WA (USA)). 1 Jul 1984. 56p. (PD-NW—84-314R). NTIS, PC A04/MF A01.

Techniques for improved use of topside-ionosphere observations within the Air Weather Service (AWS) 4D ionosphere model system are investigated. Topside observations are available at the Air Force Global Weather Central (AFGWC) from the Topside Ionospheric Plasma Monitor (SSIE) on the Block 5D DMSP satellites. The investigations cover three study areas: 10 improvements to the topside ionospheric electron-density-profile model used within the 4D model, 2) improvements to the ionospheric-data preprocessors in the 4D model system, and 3) improvements to the 4D model. Results are presented for tasks completed and in progress. An evaluation of the topside parametrization used within the International Reference Ionosphere showed it inappropriate for use in the 4D model. This led to initial development of an alternative topside parametrization based on the $O^+$ to $H^+$ transition height. The current SSIE Ne (840) data preprocessor (program SSIELD) was evaluated and found to be deficient in several areas, so work was begun on developing improvements for this program. Improvements developed for the 4D model included definition of procedures to configure the model for a full global analysis and the development of procedures to construct 4D model height functions from sets of model electron density profiles.

**21408 (AD-A—175291/4/XAB) Structure and dynamics of polar-cap F-layer patches. Interim report, March 1985-March 1986.** Weber, E.J.; Klobuchar, J.A.; Buchau, J.; Carlson, H.C.; Livingston, R.C. (Air Force Geophysics Lab., Hanscom AFB, MA (USA)). 31 Mar 1986. 23p. (AFGL-TR—86-0074). NTIS, PC A02/MF A01.

Original contains color plates: All DTIC/NTIS reproductions will be in black and white.

Coordinated measurements of F-region plasma patches were conducted on 3 and 4 February 1984 from Thule and Sondrestrom, Greenland. Optical, ionosonde, amplitude scintillation, Total Electron Content (TEC), and incoherent scatter radar measurements were combined to reveal several new aspects of the structure and transport of these localized regions of enhanced F-region ionization. These patches were directly tracked for the first time flowing antisunward from the center of the polar cap to the poleward edge of of the auroral oval. Amplitude scintillation caused by irregularities within these structured patches showed a systematic increase on the trailing edge of the patches consistent with an E X B instability mechanism. Equally important, significant scintillation was also observed on the loading edge and throughout the patch, requiring another instability mechanism to produce irregularities throughout the interior of the patch.

**21409 (AD-A—175408/4/XAB) Eigenfunction methods in magnetospheric radial-diffusion theory. Technical report.** Schulz, M. (Aerospace Corp., El Segundo, CA (USA). Space Sciences Lab.). 30 Sep 1986. 18p. (TR—0086(6940-05)-1). NTIS, PC A02/MF A01.

Complete sets of orthonormal basis functions constructed according to a generalization of the quantum-mechanical WKB approximation can be used to generate a nearly diagonal matrix representation of the radial-transport operator for ring-current ions in the presence of radial-diffusion and charge exchange. The resulting eigenfunctions (constructed by weighting the basis functions in proportion to the respective components of the eigenvectors of the matrix representation) and eigenvalues provide a spatial and temporal description of the evolving phase-space density during and following a magnetospheric disturbance (e.g., a magnetic storm). A

linear superposition of the basis functions can also be used to eliminate any discrepancy between the steady-state solution of the transport equation and the appropriate WKB approximation of this steady-state solution.

21410 **(AD-A—175490/2/XAB) Spacecraft in the magnetospheric environment. Final report, 9 November 1981-10 May 1985.** Carovillano, R.L. (Boston Univ., MA (USA). Dept. of Physics). 26 Jun 1986. 92p. NTIS, PC A05/MF A01.

This research effort dealt with environmental studies in magnetospheric physics that affect large spacecraft in space. The objectives were in four areas: computerized models of magnetospheric particle and field conditions; empirical models of precipitating particles distributions at geosynchronous altitude; plasma-beam studies and spacecraft charging; and a shuttle code to model electrical potentials and currents under various magnetospheric conditions. Scientific results and accomplishments have been reported in published journal articles and AFGL reports. The contents of this report include a documentation of the publications and detailed status reports of ongoing work. The latter include a description of the high-energy radiation-belt model developed for steady-state and time-dependent conditions, development of a model of the poleward boundary of precipitating auroral ions, study of ion signatures in the polar rain, and the relationship between the diffuse aurora and the near-earth plasma-sheet electrons.

21411 **(LA—10904-MS) Observations and theory of the AMPTE [Active Magnetospheric Particle Tracer Explorers] magnetotail barium releases.** Bernhardt, P.A.; Rousse-Dupre, R.A.; Pongratz, M.B.; Haerendel, G.; Valenzuela, A.; Gurnett, D.A.; Anderson, R.R. (Los Alamos National Lab., NM (USA)). Jan 1987. Contract W-7405-ENG-36. 48p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006325.

The barium releases in the magnetotail during the Active Magnetospheric Particle Tracer Explorers (AMPTE) operation were monitored by ground-based imagers and by instruments on the Ion Release Module. After each release, the data show the formation of a structured diamagnetic cavity. The cavity grows until the dynamic pressure of the expanding ions balances the magnetic pressure on its surface. The magnetic field inside the cavity is zero. The barium ions collect on the surface of the cavity, producing a shell. Plasma irregularities form along magnetic field lines draped over the surface of the cavity. The scale size of the irregularities is nearly equal to the thickness of the shell. The evolution and structuring of the diamagnetic cavity are modeled using magnetohydrodynamics theory. 5 refs., 28 figs., 3 tabs.

21412 **(LA-UR—87-183) Large scale instabilities and dynamics of the magnetotail plasma sheet.** Birn, J.; Schindler, K. (Los Alamos National Lab., NM (USA); Bochum Univ. (Germany, F.R.)). 1986. Contract W-7405-ENG-36. 23p. (CONF-8610233—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005101.

From 1. Huntsville workshop on magnetosphere/ionosphere plasma models; Guntersville, AL, USA (13 Oct 1986).

The stability properties of the magnetotail current sheet against large scale modes is reviewed in the framework of ideal MHD, resistive MHD, and collisionless Vlasov theory. It appears that the small deviations from a plane sheet pinch (in particular a magnetic field component normal to the sheet) are important to explain the transition of the tail from a quiet stable state to an unstable dynamic state. It is found that the tail is essentially stable in ideal MHD, but unstable in resistive MHD, while both stable and unstable configurations are found within collisionless theory. The results favor an interpretation where the onset of magnetotail dyamics leading to a sudden thinning of the plasma sheet and the ejection of a plasmoid is caused by the onset of a collisionless instability that either directly leads to the growth of a collisionless tearing mode or via microscopic turbulence to the growth of a resistive mode. The actual onset conditions are not fully explored yet by rigorous methods. The onset may be triggered by local conditions as well as by boundary conditions at the ionosphere or at the magnetopause (resulting from solar wind conditions). 53 refs., 5 figs.

21413 **(PB—87-130993/XAB) Ionospheric Communications Analysis and Prediction Program (IONCAP) (for microcomputers). Software.** Stewart, F.G. (Department of Commerce, Boulder, CO (USA). Inst. for Telecommunication Sciences). 1986. vp. NTIS CP D03.

The software is contained on 5 1/4-inch diskette, double sided, double density compatible with the IBM PC XT microcomputer. Diskettes are in the ASCII format. Price includes documentation, PB84-111210.

The computer program is an integrated system of subroutines designed to predict high-frequency (HF) skywave system performance and analyze ionospheric parameters. These computer-aided predictions may be used in the planning and operation of high-frequency communication systems using skywaves. The product consists of 4 5 1/4 inch diskettes containing 26 files: 12 Binary data files (1 for each month of the year); 8 binary-link modules (containing IONCAP compile modules); 3 Binary link modules (containing link execute module and the associated library files); 1 batch command file (for linking IONCAP program); 1 ASCII file (controls the execution of IONCAP); 1 ASCII file (for IONCAP output computations and may be routed to the printer). Software Description: The program is written in the FORTRAN programming language for implementation on an IBM PC-XT microcomputer using the DOS operating system. Memory requirement is 512K.

21414 **On the generation of field-aligned plasma flow at the boundary of the plasma sheet.** Schindler, K.; Birn, J. (Ruhr-Universitaet Bochum, Bochum, Federal Republic of Germany). *Journal of Geophysical Research;* **92**: No. A1, 95-108(1 Jan 1987).

This paper deals with a possible cause of the large plasma flow velocities parallel to the magnetic field observed near the boundary of the plasma sheet in the earth's magnetotail. For a large class of steady state configurations with typical cases involving magnetic reconnection we first show qualitatively that high parallel flow velocities can be expected to exist on field lines connecting to a region of weak magnetic field. For reconnection configurations this weak field region contains the diffusion region. The maximum value of the parallel flow velocity is sensitive to the lowest magnetic field magnitude just outside the diffusion region. The physical mechanism causing large values of the parallel velocity component v/sub parallel/ can be visualized as a strong imbalance of perpendicular mass flux into and out of magnetic flux tubes passing through regions where the magnetic field is weak and inhomogeneous. In a steady state the unbalanced perpendicular flow requires large parallel flow to establish mass conservation. The presence of a parallel velocity is not unusual in MHD systems. The new (generic) aspect is that near the separatrix, parallel flow is the dominant form of plasma transport. For a quantitative evaluation we consider an MHD model specialized for the domains where the inertia force can be neglected. By a self-consistent treatment we evaluate v/sub parallel/ and find that chemical bond v/sub parallel/ chemical bond can substantially exceed the perpendicular velocity v/sub n/ = E/B; in a typical example with stretched magnetic field lines we obtain chemical bond v/sub parallel/ chemical bond≈40v/sub perpendicular/.

21415 **Narrow- and broad-band satellite measurements of shortwave radiation: Conversion simulations with a general circulation model.** Cess, R.D.; Potter, G.L. (Laboratory for Planetary Atmospheres Research, State University of New York, Stony Brook, NY 11794). *Journal of Applied Meteorology;* **25**: No. 12, 1977-1984(Dec 1986).

The Oregon State University/Lawrence Livermore National Laboratory general circulation model has been employed as a vehicle for suggesting and exploring various means of converting narrow-band measurements of reflected solar radiation from the earth-atmosphere system to broad-band quantities. For purely illustrative purposes we have adopted, within the model's solar radiation routine, a narrow-band filter function consisting of a square-wave window extending from 0.5 to 0.9 μm. A limitation of the model, for this sort of endeavor, is that is does not include the wavelength dependence of surface albedos. Nevertheless, the model simulations tend to mimic the calibration of a narrow-band instrument, utilizing reflected solar radiation from the earth-atmosphere

system as simultaneously measured by a collocated broad-band instrument; for the model, however, this is done in terms of fluxes, in contrast to instrument-measured radiances. The model results suggest that it might be preferable to perform narrow- to broad-band conversions in terms of planetary albedo (or an equivalent quantity), rather than in terms of reflected fluxes or radiances. Further improvement is achieved if, for instruments that can differentiate between clear and overcast conditions, separate clear and overcast calibrations are performed.

21416 **Smoke-plume distributions above large-scale fires: Implications for simulations of "nuclear winter".** Penner, J.E.; Haselman L. Jr.; Edwards, L.L. (Lawrence Livermore National Laboratory, University of California, Livermore, CA 94550). *Journal of Applied Meteorology;* **25**: No. 10, 434-444(Oct 1986). Contract W-7405-ENG-48.

Smoke from raging fires produced in the aftermath of a major nuclear exchange has been predicted to cause large decreases in surface temperatures. However, the extent of the decrease and even the sign of the temperature change depend on how the smoke is distributed with altitude. We present a model capable of evaluating the initial distribution of lofted smoke above a massive fire. Calculations are shown for a two-dimensional slab version of the model and a full three-dimensional version. The model has been evaluated by simulating smoke heights for the Hamburg firestorm of 1943, and a smaller-scale oil fire which occurred in Long Beach in 1958. Our plume heights for these fires are compared to those predicted by the classical Morton-Taylor-Turner theory for weakly buoyant plumes. We consider the effect of the added buoyancy caused by condensation of waterladen ground level air being carried to high altitude with the convection column, as well as the effects of background wind on the calculated smoke plume heights for several fire intensities. We find that the rise height of the plume depends on the assumed background atmospheric conditions, as well as the fire intensity.

21417 **Magnetic reconnection in the terrestrial magnetosphere.** Feldman, W.C. (Los Alamos National Laboratory, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **144**: No. 1, 145-156(30 Jun 1986). (CONF-8408121—).

From Los Alamos workshop on magnetospheric phenomena in astrophysics; Taos, NM, USA (6 Aug 1984).

An overview is given of quantitative comparisons between measured phenomena in the terrestrial magnetosphere thought to be associated with magnetic reconnection, and related theoretical predictions based on Petschek's simple model. Although such a comparison cannot be comprehensive because of the extended nature of the process and the relatively few in situ multipoint measurements made to date, the agreement is impressive where comparisons have been possible. This result leaves little doubt that magnetic reconnection does indeed occur in the terrestrial magnetosphere. The maximum reconnection rate, expressed in terms of the inflow Mach number, M/sub A/, is measured to be M/sub A/ = 0.2 +- 0.1

21418 **Substorms in the earth's magnetosphere.** Baker, D.N. (University of California, Los Alamos National Laboratory, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **144**: No. 1, 184-207(30 Jun 1986). (CONF-8408121—).

From Los Alamos workshop on magnetospheric phenomena in astrophysics; Taos, NM, USA (6 Aug 1984).

Magnetospheres are plasma regions of large scale in space dominated by magnetic field effects. The Earth, and many planets in our solar system, are known to have magnetospheric regions around them. Magnetospheric substorms represent the intense, rapid dissipation of energy that has been extracted from the solar wind and stored temporarily in the terrestrial magnetotail. In this paper a widely, but not universally, accepted model of substorms is described. The energy budgets, time scales, and conversion efficiencies for substorms are presented. The primary forms of substorm energy dissipation are given along with the average levels of the dissipation. Aspects of particle acceleration and precipitation, Joule heating mechanisms, ring current formation, and plasmoid escape are illustrated based on in situ observations taken from the large available data base. A brief description is given of possible analogues of substorm-like behavior in other astrophysical systems.

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*REFER ALSO TO CITATION(S) 20555, 20572, 20743, 20744, 20776, 20812, 21042, 21630, 21662, 21921, 22016*

21419 **(BNL—39022) Measurement of plasma production and neutralization in gas neutralizers.** Maor, D.; Meron, M.; Johnson, B.; Jones, K.; Agagu, A.; Hu, B. (Brookhaven National Lab., Upton, NY (USA)). 17 Jun 1986. Contract AC02-76CH00016. 14p. (CONF-8606142—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005249.

From 2. joint US Army SDC/BNL neutralizer workshop; Upton, NY, USA (17 Jun 1986).

In order to satisfy the need of experimental data for the designing of gas neutralizers we have started a project aimed at measuring all relevant cross sections for the charge exchange of $H^-$, $H^0$ and $H^+$ projectiles, as well as the cross sections for the production of ions in the target. The expected results of these latter measurements are shown schematically.

21420 **(CONF-860148—9) Collisions of alkali negative ions with atomic and molecular targets.** Champion, R.; Scott, D.; Hug, M.S.; Doverspike, L. (College of William and Mary, Williamsburg, VA (USA). Dept. of Physics). 1986. Contract AS05-79ER10371. 12p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002706.

From 2. United States/Mexico cooperative symposium on atomic and molecular physics; Cocoyoc, Mexico (8 Jan 1986).

Ion-beam measurements are presented for the total cross section $\sigma$/sub e/(E) for electron detachment of $Na^-$, $K^-$, and $Cs^-$ in low-energy (E/sub lab/ < 300 eV) collisions with atomic and molecular targets. The data for the $Cs^-$ projectile is previously unreported and extends our recent study of $Na^-$ and $K^-$. The motivation for this work is due in part to the observation that these alkali-metal anions (denoted $M^-$) are similar to $H^-$ in that they have two s-electrons outside a closed shell. In particular, it is of interest to determine whether the energy dependence of $\sigma$/sub e/(E) for $M^-$ is similar to that observed for $H^-$. 21 refs., 5 figs.

21421 **(CONF-861110—6-Vugraphs) Spectral signatures from short-pulse microwave air breakdown.** Armstrong, W.T.; Roussel-Dupre, R.A.; Karl, R.; Buchwald, M.I.; Graham, G. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36;AC08-83NV10282. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006116.

From American Physical Society Plasma Physics Division meeting; Baltimore, MD, USA (3 Nov 1986).

Air breakdown $N_2$ + signatures are studied over a range of air pressures from 0.4 to 150 Torr. Short microwave pulses of frequency 3 GHz, ~ 6 ns duration and ~ 0.5 GW peak power are focused to produce air breakdown in a pressure cell region removed from walls. Diagnostics include microwave power measurements, spectroscopy, photometry and CCD imaging. Spectral signature variation with pressure, in addition to breakdown phenomenology, is discussed. 65 figs.

21422 **(CONF-861114—54) K- and L-shell resonant transfer and excitation in ion-atom collisions.** Bernstein, E.M.; Clark, M.W.; Tanis, J.A.; Graham, W.G.; McFarland, R.H.; Morgan, T.J.; Mowat, J.R.; Mueller, D.W.; Stockli, M.P.; Berkner, K.H. (Western Michigan Univ., Kalamazoo (USA). Dept. of Physics; Ulster Univ., Coleraine (UK). Dept. of Physics; Missouri Univ., Rolla (USA). Dept. of Physics; Wesleyan Univ., Middletown, CT (USA). Dept. of Physics; North Carolina State Univ., Raleigh (USA). Dept. of Physics; Louisiana State Univ., Baton Rouge (USA). Dept. of Physics). 1986. Contract AC02-83ER13116. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005808.

From 9. international conference on application of accelerators in research and industry; Denton, TX, USA (10 Nov 1986).

Recent experimental studies of resonant transfer and excitation (RTE) in ion-atom collisions are reviewed. In the RTE process correlated electron capture and projectile excitation occur together in a single encounter with a target atom. Measurements of Ca/sup

q+/ + $H_3$ (q = 10 to 19) from 100 to 370 MeV establish the projectile charge-state dependence of K-shell RTE and provide a detailed test of the theory. Structure due to RTE is observed in the energy dependence of the total electron-capture cross sections for this collision system. A comparison of the $Ca^{17+}$ + $H_3$ data with previous results for $Ca^{17+}$ + He demonstrates the effect of the target-electron momentum distribution on the RTE process. Studies of 230 to 610 MeV $Nb^{31+}$ + $H_3$ provide information about RTE involving agreement with theoretical calculations. 15 refs., 4 figs.

21423 **(CONF-8611124—2) Role of projectile anti K-electrons in single and double K-to-anti K transfer: Comparison of passive anti K-electron models and of the IFPM [independent Fermi particle model] with data for Cl/sup 17+,16+, less than or equal to 14+/ + Ti.** Becker, R.L. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 24p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87005685.

From 3. international workshop on cross sections for fusion and other applications; College Station, TX, USA (6 Nov 1986).

Electron transfer between a neutral target and a projectile ion is one of the more interesting and difficult processes to calculate. Experimentally, there is no simple, yet clean, way to measure transfer from a given shell to a given shell. For the case of K to anti K transfer (the bar designating the projectile) an indirect method is common. One measures K-vacancy cross sections for projectiles with ionic charges q = Z, Z-1, and ≦ (Z-2). Then with the assumption that the initial anti K electrons are inert, one infers the $K^1$ to anti $K^1$ and $K^2$ to anti $K^2$ cross sections from linear combinations of the measured cross sections. The postulate that anti K-electrons are inert is brought into doubt by noting that the probability of inverse (anti K to K) transfer is equal by time-reversal invariance to that for K to anti K transfer. An extensive set of such measurements has been reported recently by J. Hall for the nearly symmetric, strongly interacting systems $_{17}$Cl/sup q+/ + $_{22}$Ti. We have performed coupled-channels calculations for these systems and have compared results of various forms of the independent Fermi particle model (IFPM) with and without the assumption that any initially present anti K electron is passive. The passive anti K-electron models provide only a fair approximation to the results of the full IFPM. 5 refs., 4 figs.

21424 **(DOE/ER/13093—T1) Basic data for the development of molecules as threshold electron detectors: Final report for the period October 1983-November 1986.** Chutjian, A. (Jet Propulsion Lab., Pasadena, CA (USA)). 12 Sep 1986. Contract AI01-83ER13093. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005432.

The electron attachment properties are examined for a number of perfluorinated and chlorocarbon compounds. The experimental technique used was to be a new method developed at JPL. It allowed measurements at high electron energy resolution $\Delta\epsilon$ and at electron energies $\epsilon$ not attainable previously in such experiments.

21425 **(DOE/ER/13116—9) Correlated charge changing ion-atom collisions: Progress report for the period August 15, 1984-February 14, 1987.** Bernstein, E.M.; Tanis, J.A. (Western Michigan Univ., Kalamazoo (USA). Dept. of Physics). Feb 1987. Contract AC02-83ER13116. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005660.

Correlations between x-ray emission and charge-changing interactions have been measured for high charged ions (16 ≦ Z ≦ 23) in the energy range of 0.1 to 10 MeV/u incident on gas targets under single collision conditions. These experiments combined with theoretical studies have established the existence of resonant transfer and excitation (RTE) and indicated a close relationship between RTE and dielectronic recombination. Detailed investigations of RTE include: (1) the projectile Z dependence; (2) the projectile charge-state dependence; (3) the effect of the target electron momentum distribution; and (4) observations of RTE involving L-shell excitation. These measurements are in reasonable agreement with theoretical calculations. Evidence for non-resonant transfer and excitation has been obtained from studies of 15 to 200 MeV $S^{13+}$ + He collisions. Single-electron capture and loss were measured for 2.5 to 200 MeV $S^{13+}$ + He thereby providing a comparison with theory over a very wide energy range. For single capture in Ca/sup 16,17,18,19+ + $H_3$ a significant contribution due to RTE was observed for energies where RTE is important. Cross sections for double-electron capture for $S^{13+}$ + He and Ne and $Ar^{18+}$ + Ne were found to be 1 to 2 orders of magnitude smaller than the corresponding single-capture cross sections. Target ionization associated with projectile charge exchange has been measured for 0.5 to 1.5 MeV/u O/sup 5,6,7,8+ + He and $H_3$. 26 refs., 13 figs.

21426 **(IA—1421, pp 14) Average energy shift due to configuration interaction.** Oreg, J.; Klapisch, M.; Bar-Shalom, A. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21427 **(IA—1421, pp 8) Gamma ray laser based on induced annihilation of electron-positron pairs.** Loeb, A.; Eliezer, S. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21428 **(IAE—3992/6) Collision forces in various oxygen and carbon ions at transition excitation by electron impact.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 35p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87700875.

Results of calculation of collision forces for transitions of various multiplicity factor of carbon and oxygen ions carried out using different methods (Coulomb-born approximation, Coulomb-born approximation with exchange, method of strong coupling) are presented. 10 refs.; 1 tab.

21429 **(IC—86/28) Effect of excitation frequency on temperature dependent electroluminescence of ZnS : Cu, Mn : (H).** (International Centre for Theoretical Physics, Trieste (Italy)). Apr 1986. 10p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701381.

The temperature dependent electroluminescence yields of Hydrogen coactivated (ZnS : Cu, Mn) Phosphor have been investigated under the influence of excitation field frequencies. It was observed that brightness maximum of electroluminescent intensity shifts towards higher temperature region for all emissions. The shift for blue emission is remarkable at some higher frequency. Electroluminescent output under simultaneous effect of frequency and temperature shows the validity of interrelation, f=A e(-c/KT). 8 refs, 4 figs.

21430 **(IC—86/29) Temperature dependence of electroluminescent emission from (ZnS : Cu, Mn(H)) type luminophors.** (International Centre for Theoretical Physics, Trieste (Italy)). Apr 1986. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701382.

The dependence of electroluminescent yield on temperature for hydrogen coactivated (ZnS : Cu, Mn) type triple band emitting phosphors has been investigated at various temperatures under varied operating conditions of excitations. The influence of the excitation frequency, voltage and of emission wavelengths for the electroluminescent characteristics has also been observed on temperature variations. The results have also been studied for temperature dependences of emitting brightness under the excitation by UV-radiations of 3650 A.U. and a comparison is made between temperature dependent characteristics of E.L. and PL-brightness of emissions. It was observed that, as usual, brightness maxima on temperature scale varied with alteration of operating electric fields regarding frequency and voltage both for blue, green and yellow orange emissions of attempted samples. The important thing which is observed here, is that with regards the temperature EL-intensities vary respectively for all respective emissions but emission peaks are not shifted on wave-length scale. This no shift is due to the narrowly and compactly distributed coactivator levels of hydrogen. 7 refs, 4 figs.

21431 **(IC—86/91) Split-target technique in determining the dE/dX of 1.0-5.0 MeV tritium in A1, Ni and Au.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701391.

The energy loss of 1.0 to 5.0 MeV tritium in aluminium, nickel and gold have been measured by a split-target technique. The data have been analysed by integrating an analytical expression for the variation of dE/dX with energy. The results are compared with semi-empirical calculations and with previously determined values. 13 refs, 6 figs, 2 tabs.

21432 **(IC—86/119) New approach to bound-state quantum electrodynamics-II: Spectra of positronium, muonium and hydrogen.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701383.

The solutions of a covariant two-body equation are applied to the spectra of H, muonium and positronium. In order to compare with the standard results we have expanded the potentials, the recoil terms and the perturbation calculations up to order $\alpha$/sup 5/. The best known intervals, namely Hfs of H, muonium and positronium and the 2/sup 3/S/sub 1/ - 1/sup 3/S/sub 1/ interval of positronium are obtained to this order in agreement with standard results and experiments. Having thus verified the nonperturbative equation to order $\alpha$/sup 5/, the recoil and normal and anomalous magnetic moment terms can now be evaluated numerically to all orders. 18 refs.

21433 (INIS-SU—385, pp 39-44) **Renormalization group calculation of some contributions to hyperfine splitting of the ground level in muonium.** Starshenko, V.V.; Faustov, R.N. (Moskovskij Gosudarstvennyj Univ., USSR; Joint Inst. for Nuclear Research, Dubna, USSR). 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780104. (N—7-85).

In JINR rapid communications. Collection.

The paper deals with the contribution of the terms, depending on logarithm of muon and electron masses ratio, to the hyperfine splitting of the ground level in muonium. In the case of diagrams with radiation corrections to photon lines these terms are calculated on the basis of hyperfine splitting invariance under choice of renormalization scheme for photon propagator. 10 refs.

21434 **(INIS-SU—385) JINR rapid communications. Collection.** (Joint Inst. for Nuclear Research, Dubna (USSR)). 1985. 59p. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780104.

Individual papers have been cataloged separately. (WRF)

21435 (INIS-SU—392, pp 546) **Transition radiation of positronium relativistic atom.** Kunashenko, Yu.P. 1986. (In Russian). NTIS (US Sales Only), PC A99/MF A01. File Number DE87780053. (CONF-8604278—Summs.).

From 36. conference on nuclear spectroscopy and nuclear structure; Khar'kov, USSR (15 Apr 1986).

21436 (INIS-SU—398, pp 80-89) **Elastic waves induced in a semi-infinite body with cover by a pulse radiation.** Davydov, A.A.; Kalinichenko, A.I.; Lazurik, V.T. 1985. (In Russian). NTIS (US Sales Only), PC A05/MF A01. File Number DE87780090.

In Problems of nuclear physics and cosmic rays. No. 23. Republican Interinstitute scientific technical collection.

The results of theoretical investigations of elastic waves induced in a two-layer construction with quite different layer thickness are presented. Possibility to determine thickness of a thin layer (cover) by and acoustic signal excited by a pulsed irradiation flux and registered at a point lying inside the second layer (substrate) at a considerable distance x from an interphase. Effect of a radiation type and generating abilities of each layer as well as effect of the cover thickness on the excited acoustic impulse investigated. 8 refs.; 3 figs.

21437 (INIS-SU—398, pp 90-93) **Calculation of the target atom recoil emission coefficient from (n, $\gamma$)-reaction.** Afanas'ev, V.D.; Getmanets, O.M. 1985. (In Russian). NTIS (US Sales Only), PC A05/MF A01. File Number DE87780090.

In Problems of nuclear physics and cosmic rays. No. 23. Republican Interinstitute scientific technical collection.

The paper deals with quantitative calculations of radioactive contribution of recoil atoms from (n,$\gamma$) reaction to material sputtering in a reactor under irradiation. Numerical evaluations of the Ta/sup 181/ target recoil atom emission coefficient (Ssub(r)) are carried out. Good agreement between calculation and experimental Ssub(r) in marked. The paper results are marked to be applied not only in case of (n,$\gamma$) reactions, but for a wide class of the processes, where recoil atom emission occurs. 5 refs.

21438 **(ITEP—37(1985)) Muon sticking to helium in the muon catalyzed fusion dd$\mu$ -> $\mu$/sup 3/He + n.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 11p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700984.

The coefficient of muon sticking to helium in the nuclear fusion reaction dd$\mu$ -> $\mu$/sup 3/He+n from the states (Jv)=(11) and (Jv)=(10) of the mesic molecule dd$\mu$ is calculated $\omega$sub(s)sup(0)=0.133. The mesic molecule wave functions used include the non-adiabatic effects in the nuclei motion. With the muons shaking off taken into account the sticking probability $\omega$sub(s)=0.12 is in a good agreement with the experimental value $\omega$sub(s)=0.126+-0.004. 17 refs.; 1 fig.; 2 tabs.

21439 **(JINR—E-1-86-107) Evaluation of the possibility for determining the parameters of the T$\mu$-atom charge exchange on Helium.** (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1986. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701384.

The kinetic formulae describing $\mu$-atomic and $\mu$-molecular processes in a T/sub 2//He target are presented. These formulae were applied to predict the results of experiments aimed at determining the values of probability of the t/sub $\mu$/*-atom formation in its ground state and the rate of muon transfer from t/sub $\mu$/ in the ground state to helium (lambda/sub He//sup 0/). It is estimated that variation of the helium concentration in the 0-0.4 range at two tritium densities (phi < or approximately 0.2) is sufficient in this kind of experiment. 20 refs.

21440 **(JINR—E-2-85-834) Interaction of elementary atoms with matter.** (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1985. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701385.

The physics of elementary atoms, i.e. Coulomb bound states like positronium, pionium, etc., is briefly presented. The formulae for cross sections of elementary atom interaction with an external field are evaluated in the nonrelativistic and Born approximations. The numerical calculations of the total, elastic and excitation cross sections are performed for seven elementary atoms and five typical targets. It was used two type of interaction potential: Coulomb simple screened potential and namely, Thomas-Fermi-Molier potential. Atomic form factors are discussed in detail. 21 refs.

21441 **(JINR—R-4-85-917) Variational calculation of energy levels of mesic molecules of hydrogen isotopes.** (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1985. 15p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701387.

Submitted to the journal Sov. Phys. - JETP.

Variational calculations of energy levels epsilonsub(Jv) of 18 rotational-vibrational states (Jv) of mesic molecules of hydrogen isotopes with the total angular - momenta J=0 and J=0 are performed. The set of 1000 basis functions has been used, which has permitted to calculate the binding energy with an accuracy 0.001 eV. For weakly bound states (J=1, v=1) of the dd$\mu$ and dt$\mu$ mesic molecules the values epsilon/sub 11/(dd$\mu$)=-1.975 +- 0.001 eV

and epsilon/sub 11/(dtμ)=-0.657 +- 0.002 eV are obtained. 22 refs.; 5 tabs.

21442 **(JINR—R-11-85-758) Alternating subspace iteration method for numerical solution of tree-dimensional spectral problems of mathematical physics.** (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1985. 15p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701386.

An alternating subspace iteration method for simultaneous calculation the smallest p eigenpairs (lambda, x) of the general algebraic problem Ax=lambdaBx is proposed. Matrices A and B symmetric, positive-definite of order N >> 1. This method is used for numerical solution of three-dimensional Schroedinger equation, that describes the energies and wave functions of the bound states for mesic molecules of hydrogen isotopes. Matrices A and B are obtained as a result of the finite element approximation of this equation. Binding energies for mesic molecules ddμ and ttμ are calculated with 10/sup -2/ eV accuracy. 20 refs.; 7 tabs.

21443 **(KFKI—1986-31/D) Optically pumped FIR lasers and their application in plasma diagnostics.** (Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics). Jun 1986. 45p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87701389.

The pysics and the construction of the far infrared lasers (FIRL) and of the infrared lasers pumping them are reviewed. The details of the construction, resonating and pumping systems, spectral and power characteristics of the FIRLs are discussed. Recently more than 1000 laser lines are known and used in the 27-80 mm wavelength range, but in many cases the laser kinetics are not fully understood, and some instability phenomena cannot be prevented. New nonlinear processes were found: two-photon pumping, hyper Raman laser tuning and relaxation phenomena. A broad application field, the plasma diagnostics by far infrared lasers is described. Scattering of infrared laser radiation can give new interesting information on the not understood effect of the anomalous transport in the high temperature plasma. (D.Gy.). 86 refs.; 32 figs.

21444 **(LBL—22466) Theoretical study of intermolecular energy transfer involving electronically excited molecules: $He(^1S) + H_2(B\ ^1\Sigma/sub\ u/^+)$.** Grimes, R.M. (California Univ., Berkeley (USA)). Nov 1986. Contract AC03-76SF00098. 206p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE87006172.

To further understanding of gas phase collision dynamics involving electronically-excited molecules, a fully quantum mechanical study of $He + H_2(B\ ^1\Sigma/sub\ u/^+)$ was undertaken. Iterative natural orbital configuration interaction (CI) calculations were performed to obtain the interaction potential between He and $H_2(B\ ^1\Sigma/sub\ u/^+)$. The potential energy surface (PES) is highly anisotropic and has a van der Waals well of about 0.03 eV for C/sub 2v/ approach. Avoided PES crossings occur with $He + H_2(E,F\ ^1\Sigma/sub\ g/^+)$ and with $He + H_2(X\ ^1\Sigma/sub\ g/^+)$ and cause a local maximum and a deep minimum in the $He + H_2(B\ ^1\Sigma/sub\ u/^+)$ PES, respectively. The crossing with $He + H_2(X\ ^1\Sigma/sub\ g/^+)$ provides a mechanism for fluorescence quenching. The computed CI energies were combined with previous multi-reference double excitation CI calculations and fit with analytic functions for convenience in scattering calculations. Accurate dipole polarizabilities and quadrupole moment of $H_2(B\ ^1\Sigma/sub\ u/^+)$ were computed for use in the multipole expansion, which is the analytic form of the long-range PES. 129 refs., 28 figs., 35 tabs.

21445 **(PB—87-126611/XAB) Physics at the laser-atomic frontier. Final report.** (National Academy of Sciences, Washington, DC (USA). Commission on Physical Sciences, Mathematics, and Resources). 1986. 65p. NTIS, PC A04/MF A01.

Laser-based research is one of the most rapidly developing areas in the field of atomic, molecular, and optical physics. The many new scientific opportunities and the broad impact of this research on neighboring sciences and federal and industrial programs made this a natural subject for inclusion in Selected Opportunities in Physics, a research briefing that was prepared at the request of the Office of Science and Technology Policy and the National Science Foundation. To portray the opportunities described in the briefing, the Committee on Atomic and Molecular Science (CAMS) of the National Research Council sponsored a workshop on the Laser-Atomic Frontier, which was held at the National Academy of Sciences on October 11, 1985. The report documents the presentations of that workshop. Topics discussed include the following: The new spectroscopies; Light under control -- a new generation of radiation sources; Trapped and laser-cooled particles; Intense electromagnetic fields in laser-atomic interactions; Laser science in industry; National programs at the laser-atomic frontier; Laser-atomic research in universities.

21446 **Stark, Zeeman, and hyperfine properties of v = 0, v = 1, and the equilibrium configuration of hydrogen fluoride.** Bass, S.M.; DeLeon, R.L.; Muenter, J.S. (Department of Chemistry, University of Rochester, Rochester, New York 14627). *Journal of Chemical Physics;* **86**: No. 8, 4305-4312(15 Apr 1987).

Molecular beam electric resonance spectroscopy has been done on the v = 0 and v = 1 states of hydrogen fluoride in external electric and magnetic fields. The v = 1 state was populated using a color center laser. v = 0, v = 1, and equilibrium configuration results have been obtained for the HF dipole moment, fluorine and proton spin rotation interactions, fluorine and proton magnetic shielding anisotropies, both direct and indirect spin—spin interactions, rotational magnetic moment, and magnetic susceptibility. All of these properties can be extrapolated to v = 2 with high accuracy and to higher states with reasonable confidence. First and second derivatives with respect to internuclear distance have also been obtained for several of these properties. Comparisons of HF and DF dipole moments indicate significant differences arising from Born—Oppenheimer breakdown.

21447 **Localization effects in the Auger spectra of ring nitrogen systems: Pyridine, poly(2-vinyl)pyridine, borazine, and boron nitride.** Rye, R.R.; Kelber, J.A.; Kellogg, G.E.; Nebesny, K.W.; Lichtenberger, D.L. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Chemical Physics;* **86**: No. 8, 4375-4383(15 Apr 1987). Contract AC02-80ER10746.

The N(KVV) Auger spectra of gas phase pyridine ($C_5H_5N$) and borazine ($B_3N_3H_6$), and of solid phase poly(2-vinyl)pyridine (PVP) and hexagonal boron nitride [(BN)/sub x/] are reported and analyzed. The data indicate two Auger "fingerprint" types of nitrogen. Ammonia ($NH_3$) is the prototype for the first, where three of the five valence electrons are $\sigma$ bonding and the other two are the lone pair. This localized electronic structure gives rise to relatively sharp features in the N(KVV) spectrum. Typical of the second fingerprint type is pyridine, where there are two $\sigma$ bonding electrons, a lone pair of electrons, and one electron contributing to the delocalized $\pi$ system. Theoretical nitrogen Auger transition energies and intensities are calculated for pyridine to demonstrate the general origin of the overlapping features in the relatively broad N(KVV) spectrum of this molecule. PVP fits into the second fingerprint type while borazine and boron nitride give nitrogen Auger spectra more like ammonia. Approximate calculations using the equivalent core concept are used to clarify the relationship between the ammonia, borazine, and boron nitride spectra. It is shown that in these systems the initial Auger state (core—hole) largely localizes the bonds and lone pair on the nitrogen. The Auger spectra show that it is the $\sigma$, $\pi$ and nonbonding orbital characters that provide the Auger fingerprint.

21448 **Structure and bonding of $F_2O_2$.** Rohlfing, C.M.; Hay, P.J. (Theoretical Division, Sandia National Laboratories, Livermore, California 94550). *Journal of Chemical Physics;* **86**: No. 8, 4518-4522(15 Apr 1987).

The geometry of $F_2O_2$ is determined by several ab initio methods, including Mo-dash-barller—Plesset perturbation theory (MP) based on an RHF reference and externally contracted configuration interaction (CCI) based on a complete-active-space (CAS) reference. Basis sets with polarization and diffuse functions are used. Compared to the gas-phase experimental structure, SCF and MP bond lengths are very poor, and the MP geometries vary considerably with basis set changes. Three sizes of CAS are examined

and each results in a dissociative surface. Only CCI calculations from a large CAS produce a geometry in reasonable agreement with experiment. After addition of Davidson's correction, the remaining errors in the O—O and O—F bond lengths are 0.016 and 0.025 A, respectively.

21449 **Multiphoton spectroscopy of X—NO (X = Kr, Xe, $CH_4$) van der Waals molecules.** Miller, J.C. (Chemical Physics Section, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Chemical Physics;* **86**: No. 6, 3166-3171(15 Mar 1987). Contract AC05-84OR21400.

The vibronic spectroscopy of the van der Waals species KrNO, XeNO, and $CH_4NO$ has been investigated via mass-resolved multiphoton ionization (MPI) spectroscopy. Spectra are presented for the two-photon excited electronic transition of the various complexes associated with the C $^2$Pi (v = 0) state of nitric oxide. Dissociation pathways are analyzed for XeNO, which appears at the $Xe^+$ mass following MPI. Trends in bonding and spectroscopic constants are discussed.

21450 **Stolterfoht et al. respond.** Stolterfoht, N.; Havener, C.C.; Phaneuf, R.A.; Swenson, J.K.; Shafroth, S.M.; Meyer, F.W. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review Letters;* **58**: No. 9, 958-958(2 Mar 1987). Contract AC05-84OR21400.

A reply to the comment on evidence for correlated double electron capture in low energy collisions of multiply-charged oxygen ions with He is presented. (AIP)

21451 **Fluorescence polarization studies of autoionization in $CS_2$.** Poliakoff, E.D.; Dehmer, J.L.; Parr, A.C.; Leroi, G.E. (Department of Chemistry, Boston University, Boston, Massachusetts 02215). *Journal of Chemical Physics;* **86**: No. 5, 2557-2562(1 Mar 1987).

The polarization of the $CS^+_2$(A $^2$Pi→X $^2$Pi) transition was measured following photoionization of $CS_2$ with synchrotron radiation excitation in the range 875 A<λ/sub exc/ <967 A. Autoionization features are prominent in the fluorescence polarization spectrum and were investigated in detail. The spectral assignments of the absorption spectrum by Ogawa and Chang [Can. J. Phys. 48, 2455 (1970)] are supported by the current measurements. Although fluorescence excitation and fluorescence polarization profiles normally align precisely, exceptions have been found for many resonances (σ/sub u/ →nd$\pi$, n>3), and comparisons between the line shapes are given for several features.

21452 **Infrared spectrum of the acetylene radical cation $C_2H^+_2$. A theoretical study using SCF, MCSCF, and CI methods.** Lee, T.J.; Rice, J.E.; Schaefer, H.F. III. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Journal of Chemical Physics;* **86**: No. 5, 3051-3053(1 Mar 1987).

Within the harmonic approximation, the vibrational frequencies and infrared intensities of the $C_2H^+$/sub /$_2$ electronic ground state have been predicted using ab initio molecular quantum mechanics. A standard double zeta plus polarization (DZ+P) basis set of contracted Gaussian functions was employed. Self-consistent-field (SCF), multiconfiguration (MC) SCF, and configuration interaction (CI) methods were used.

21453 **Slow collisions of $H^-$ and $D^-$ with Na and K.** Wang, Y.; Champion, R.L.; Doverspike, L.D. (Department of Physics, College of William and Mary, Williamsburg, Virginia 23185). *Physical Review [Section] A: General Physics;* **35**: No. 4, 1503-1509(15 Feb 1987).

Relative cross sections for charge transfer and electron detachment in collisions of $H^-$ and $D^-$ ions with Na and K atoms have been measured in the energy range from 2 to 300 eV. Measurements of the differential elastic cross sections for collisions of $H^-$ with Na are also reported for energies around 10 eV. A two-state perturbed-stationary-state calculation has been performed and compared with the experimental results and a previous calculation.

21454 **Surface vibrational spectroscopy by infrared-visible sum frequency generation.** Zhu, X.D.; Suhr, H.; Shen, Y.R. (Department of Physics, University of California, Berkeley, California 94720 and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Physical Review [Section] B: Condensed Matter;* **35**: No. 6, 3047-3050(15 Feb 1987).

We report the first observation of a vibrational spectrum of a monolayer of molecular adsorbates by infrared-visible sum frequency generation. The results pave the way for future dynamic studies of surface phonons and molecular vibrations.

21455 **Laser-based foilless diode.** Shope, S.L.; Frost, C.A.; Leifeste, G.T.; Poukey, J.W. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Physical Review Letters;* **58**: No. 6, 551-554(9 Feb 1987). Contract AC04-76DP00789.

A new foilless diode has been developed that does not require an external magnetic field to control beam expansion of an intense relativistic electron beam (IREB). An ionized channel, formed with use of a laser, extends through the transport region and terminates at the cathode of an IREB accelerator. When a negative potential is applied to the cathode, channel electrons are expelled leaving a positive core that electrostatically attracts and focuses the emitted electrons. A 3.6-MeV, 25-kA electron beam has been generated and transported 1.3 m by use of this technique.

21456 **Surface properties of metal-nitride and metal-carbide films deposited on Nb for radio-frequency superconductivity.** Garwin, E.L.; King, F.K.; Kirby, R.E.; Aita, O. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Journal of Applied Physics;* **61**: No. 3, 1145-1154(1 Feb 1987). Contract AC03-76SF00515.

Various effects occur which can prevent attainment of the high Q's and/or the high gradient fields necessary for the operation of radio-frequency (rf) superconducting cavities. One of these effects, multipactor, both causes the cavity to detune during filling due to resonant secondary electron emission at the cavity walls, and lowers the quality factor (Q) by dissipative processes. TiN deposited onto the high-field regions of room-temperature Al cavities has been used at the Stanford Linear Accelerator Center to successfully reduce multipactor in the past. We have therefore studied TiN and its companion materials, NbN, NbC, and TiC, all on Nb substrates under several realistic conditions: (1) as-deposited, (2) exposed to air, and (3) electron bombarded. The studied films (up to 14-nm thickness) were sputter deposited onto sputter-cleaned Nb substrates. Results indicate that all the materials tested gave substantially the same results. The maximum secondary electron yields for as-deposited films were reduced to nearly the preoxidized values after electron bombardment (2—3 x $10^{17}$ electrons $cm^{-2}$ in the case of NbN and NbC). X-ray photoelectron spectroscopy analysis showed that the oxides (e.g., $TiO_2$ in the case of TiN films) formed during air exposure were slightly reduced (converted to lower oxides) by the electron-beam exposure. Auger electron spectroscopy (AES) showed a slight reduction in the surface O concentration following beam exposure. These results suggest that the chemical nature of top surface layers is responsible for the substantial changes in secondary electron yield observed upon electron-beam exposures and that AES does not reflect this change strongly because of the difficulty in extracting chemical (versus elemental) information from AES.

21457 **Four-photon excitation of even-parity Rydberg states in krypton and xenon.** Blazewicz, P.R.; Stockdale, J.A.D.; Miller, J.C.; Efthimiopoulos, T.; Fotakis, C. (Chemical Physics Section, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review [Section] A: General Physics;* **35**: No. 3, 1092-1098(1 Feb 1987). Contract AC05-84OR21400.

Multiphoton ionization via four-photon excitation of high-lying Rydberg states in xenon and krypton has been studied. The p and f series leading to the $^2$P/sub 3/2/ ionization limits as well as the p' and f' autoionizing levels leading to the $^2$P/sub 1/2/ limits have been recorded for both gases. Lower members of the p series in xenon are resolved into p[(5/2)]$_3$, p[(3/2)]$_2$, and p[(1/2)]$_0$ sublev-

els. Ionization potentials and quantum defects are obtained by a least-squares fitting of the data to the standard Rydberg formula.

21458 **Sr 5pnd J = 3 autoionizing series and interference of excitation due to bound-state perturbation.** Xu, E.Y.; Zhu, Y.; Mullins, O.C.; Gallagher, T.F. (Department of Physics, University of Virginia, Charlottesville, Virginia 22901). *Physical Review [Section] A: General Physics;* **35**: No. 3, 1138-1148(1 Feb 1987).

Using the isolated-core-excitation method we have measured the energies and widths of the three Sr J = 3 autoionizing 5pnd Rydberg series for n = 11—36. We have fitted our data to a six-channel multichannel quantum-defect theory model reproducing the observed energies, widths, and interactive excitation spectra for the three series. In addition, the effect of the bound 4d6s $^1D_2$ and 4d6s $^3D_2$ perturbers, which mix the bound 5snd $^1D_2$ and $^3D_2$ states, on the excitation spectra has been observed and accounted for.

21459 **Stripping of $\mu p$ from $\alpha\mu$ after muon-catalyzed fusion: Effect of target structure.** Cohen, J.S. (Theoretical Division, Los Alamos National Laboratory, University of California, Los Alamos, New Mexico 87545). *Physical Review [Section] A: General Physics;* **35**: No. 3, 1419-1422(1 Feb 1987).

Stripping (ionization and transfer) and excitation cross sections for the muonic helium ion ($\alpha\mu$) in deuterium-tritium mixtures are calculated by the classical-trajectory Monte Carlo method. It is shown by direct (three- and four-body) calculations that the effects of the target electronic structure and finite mass are not important.

21460 **Retrievable UHV effusion cell for investigation of low melting point metals on solid surfaces.** Castro, T.; Reifenberger, R. (Purdue University, Department of Physics, West Lafayette, Indiana 47907). *Review of Scientific Instruments;* **58**: No. 2, 289-292(Feb 1987).

The design and performance of an effusion cell used to deposit low melting point metals under UHV conditions is described. A novel feature of the cell is a transfer rod and pretreatment chamber that allow for the rapid loading and retrieval of crucibles containing low melting point source elements. This feature of our cell makes it ideal for depositing the highly reactive alkali metals. The performance of the effusion cell is evaluated for the deposition of the metal potassium.

21461 **Rigorous finite-basis-set approach to the calculation of the angular dependence of photoionization.** McCurdy, C.W.; Rescigno, T.N. (Department of Chemistry, Ohio State University, Columbus, Ohio 43210). *Physical Review [Section] A: General Physics;* **35**: No. 2, 657-663(15 Jan 1987).

A practical solution is provided for the problem of using finite-basis-set methods to calculate the asymmetry parameter, $\beta(E)$, which determines the angular dependence of photoejection in the dipole approximation. This problem has been an outstanding limitation of basis-set approaches to photoionization in general, which have heretofore been able only to produce the total cross section. The procedure proposed here is given in two forms: an evaluation of the differential cross section in terms of the outgoing flux, and an alternative prescription involving matching to the outgoing wave function. In both cases the method of complex basis functions is used to compute the necessary matrix elements of the electronic Green's function. Numerical results are reported for $\beta(E)$ for ionization of the 2p state of atomic hydrogen.

21462 **Double- and single-electron capture and loss in collisions of 1—2-MeV/u boron, oxygen, and silicon projectiles with helium atoms.** Hippler, R.; Datz, S.; Miller, P.D.; Pepmiller, P.L.; Dittner, P.F. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review [Section] A: General Physics;* **35**: No. 2, 585-590(15 Jan 1987). Contract AC05-84OR21400.

Single- and double-electron-capture cross sections were measured for 1—2-MeV/u bare B/sup 5+/, O/sup 8+/, and Si/sup 14+/ projectiles in collisions with helium atoms. The measured double-electron-capture cross sections are 2—3 orders of magnitude smaller than corresponding single-capture cross sections. The single-capture cross sections are well described by continuum-distorted-wave calculations. For B/sup 5+/, the double-capture cross sections at high velocities are in reasonable agreement with scaled Oppenheimer-Brinkman-Kramers calculations, assuming capture of independent electrons. Cross sections for electron capture and loss are also reported for nonbare ions (O/sup 6+/, O/sup 7+/, Si/sup 8+/, and Si/sup 13+/). Single-capture cross sections for nonbare ions are about 30% smaller than corresponding cross sections for bare ions with the same ionic charge q. The reported electron-loss cross sections are well described as ionization of an ion by an incident helium nucleus and two free electrons, using theoretical ionization cross sections in the Born approximation.

21463 **Determination of the branching of the $^1P_1$ Ba I level from studies of the intensity dependence of resonance fluorescence.** Lewis, D.A.; Kumar, J.; Finn, M.A.; Greenlees, G.W. (Physics Department, Iowa State University, Ames, Iowa 50011). *Physical Review [Section] A: General Physics;* **35**: No. 1, 131-134(1 Jan 1987).

The resonance fluorescence from the /sup 138/Ba I 5535-A $6s^{21}S_0$-6s6p $^1P_1$ transition has been measured as a function of incident intensity using a Doppler-free atomic beam geometry and a single-mode cw dye laser. The upper $^1P_1$ level has a weak branch to intermediate metastable D states. A long laser-atom interaction region was used, which ensured that essentially all atoms could be pumped into the D states during their transit through the laser beam. By analyzing the shape of the saturation curve a value for the branching ratio to the 6s5d /sup 1,3/D levels of (3.57 +- 0.38) x 10/sup -3/ has been obtained.

21464 **Multiphoton ionization of hydrogen: A time-dependent theory.** Kulander, K.C. (Theoretical Atomic and Molecular Physics Group, V Division, Physics Department, Lawrence Livermore National Laboratory, Livermore, California 94550). *Physical Review [Section] A: General Physics;* **35**: No. 1, 445-447(1 Jan 1987).

Results of calculations using a novel numerical method for intense-field, low-order multiphoton ionization of hydrogen are reported and compared to previously published values. The technique involves the explicit numerical solution of the time-dependent Schroedinger equation using a finite-difference representation of the electronic wave function.

21465 **2l-3l′ and 2l-4l′ transitions in heliumlike and hydrogenlike silicon.** Feldman, U.; Ekberg, J.O.; Brown, C.M.; Seely, J.F.; Richardson, M.C. (E.O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, DC 20375-5000). *Journal of the Optical Society of America B: Optical Physics;* **4**: No. 1, 103-104(Jan 1987).

Wavelengths are reported for the n = 2-n = 3 and n = 2-n = 4 transitions of Si XIII and Si XIV, as observed in a laser-heated plasma. The wavelength range of the observations is 24—40 A.

21466 **Observation of molecular vibrations in real time.** Ha, J.M.Y.; Maris, H.J.; Risen W.M. Jr.; Tauc, J.; Thomsen, C.; Vardeny, Z. (Brown University, Providence, Rhode Island 02912). *Physical Review Letters;* **57**: No. 26, 3302-3302(29 Dec 1986).

A Comment on the Letter by M. J. Rosker, F. W. Wise, and C. L. Tang, Phys. Rev. Lett. 57, 321 (1986).

21467 **Observation of resonant transfer and excitation to specific LS-coupled states in O/sup 5+/+He collisions by high-resolution, 0° Auger-electron spectroscopy.** Swenson, J.K.; Yamazaki, Y.; Miller, P.D.; Krause, H.F.; Dittner, P.F.; Pepmiller, P.L.; Datz, S.; Stolterfoht, N. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review Letters;* **57**: No. 24, 3042-3045(15 Dec 1986). Contract AC05-84OR21400.

Conclusive evidence is presented for resonant transfer and excitation to specific intermediate states in collisions of Li-like O/sup 5+/ with He. Using the technique of high-resolution 0° Auger-electron spectroscopy, we observed a maximum in the cross section for production of Be-like $1s2s2p^2$ $^3D$ and $1s2s2p^2$ $^1D$ states as function of incident ion energy. The peak appears at —13 MeV with a

width of —7 MeV and is in good agreement with the impulse approximation model for resonant transfer and excitation.

21468 **Lamb shift in helium-like uranium (U/sup 90+/).** Munger, C.T.; Gould, H. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Physical Review Letters;* **57**: No. 23, 2927-2930(8 Dec 1986). Contract AC03-76SF00098.

We report a value of 70.4 +- 8.3 eV for the one-electron Lamb shift in uranium, in agreement with the theoretical value of 75.3 +- 0.4 eV. We extract our Lamb shift from a beam-foil time-of-flight measurement of the (54.4 +- 3.4)-ps lifetime of the 1s2p/sub 1/2/ $^3P_0$ state of helium-like uranium.

21469 **Effects of autoionization on the photoionization induced alignment of cadmium II ($4d^9\,5s^2\ ^2D$/sub 5/2/).** Goodman, Z.M. New Haven, CT; Yale Univ. (1986). 174p. University Microfilms Order No. 86-12,962.

Thesis (Ph. D.).

The benchmark process for photoionization-induced alignment in atoms is the fluorescence decay of the excited d hole states of $Cd^+$. Fluorescence polarization measurements, from which alignment is derived, have been made using rare gas lamps and synchrotron radiation at lower resolution. Although evidence had been seen for effects due to the presence of autoionizing resonances, a detailed study of the variation of alignment through an autoionizing resonance had not been made. This thesis reports just such a measurement for the autoionizing $4d^9 5s^2(^2D$/sub 3/2/)np $^3P_1$ and $4d^9 5s^2(^2D$/sub 3/2/)nf $^1P_1$ series in Cd. These Rydberg states, corresponding to the excitation of a single inner-shell electron, form a well-characterized series converging on the $^2D$/sub 3/2/ fine-structure threshold at 678.3 A. The experiment was performed at the National Synchrotron Light Source (Brookhaven National Laboratory) on beamline U-11. Dispersed synchrotron radiation was crossed with an effusive cadmium beam. Wavelength- and polarization selected fluorescence radiation was detected perpendicular to the two beams. The polarization and alignment data show marked variations on the order of 25% across the resonance profiles, which cannot be reproduced by RRPA-MQDT calculations. This thesis analyzes for the first time the strong effects of bound continuum coupling on the alignment.

21470 **Ab initio study of cyanogen: the X vector $_1u$/sub g/$^+$, a vector$^3\Sigma$/sub u/$^+$, B vector$^1\Delta$/sub u/, and C vector$^1\Pi$/sub u/ states.** Dateo, C.E.; Dupuis, M.; Lester, W.A. Jr. (Lawrence Berkeley Lab., CA). *Journal of Chemical Physics;* **83**: No. 1, 265-272(1 Jul 1985). Contract AC03-76SF00098.

An ab initio multiconfiguration Hartree-Fock (MCHF) study of the X vector $^1\Sigma$/sub g/$^+$, a vector $^3\Sigma$/sub u/$^+$, B vector $^1\Delta$/sub u/, and C vector $^1\Pi$/sub u/ states of cyanogen ($C_2N_2$) is presented. Equilibrium structures, harmonic vibrational frequencies, excitation energies, and dissociation energies have been calculated and found to be in semiquantitative agreement with available experimental data. This study confirms the $\pi \rightarrow \pi^*$ character of $C_2N_2$ (a vector $^3\Sigma$/sub u/$^+$) and $C_2N_2$ (B vector $^1\Delta$/sub u/), and the $n \rightarrow \pi^*$ character of $C_2N_2$ (C vector $^1\Pi$/sub u/) near their equilibrium structures. Configuration mixing among the n and $\pi$ electrons in needed to correct the broken symmetry description given by the Hartree-Fock (HF) method, and leads to a qualitatively correct representation of these states. For $C_2N_2$ (a vector $^3\Sigma$/sub u/$^+$) and $C_2N_2$ (B vector $^1\Delta$/sub u/), the harmonic force constants show a strong through-bond interaction which is due to the dominance of the charge transfer configuration $^+NCCN^-$. For $C_2N_2$ (C vector $^1\Pi$/sub u/) the trans-bending vibrational mode and the cis-bending mode lead to different Renner-Teller splittings: the lower $^1A'$ state most likely has a slightly trans-bent minimum energy structure. The calculated harmonic stretching frequencies of $C_2N_2$ (C vector $^1\Pi$/sub u/) are $\nu_1$ (sym. CN str.) = 2145 $cm^{-1}$, $\nu_2$ (CC str.) = 989 $cm^{-1}$, and $\nu_3$ (asym. CN str.) = 1789 $cm^{-1}$. 20 references, 6 figures, 8 tables.

21471 **X-ray-absorption spectra in $KrF_2$ and $FeCl_3$: theory.** Chou, S.H.; Kutzler, F.W.; Ellis, D.E.; Shenoy, G.K.; Morrison, T.I.; Montano, P.A. (Northwestern Univ., Evanston, IL). *Physical Review* [*Section*] *B: Condensed Matter;* **31**: No. 2, 1069-1076(15 Jan 1985).

Theoretical x-ray-absorption near-edge structure (XANES) and extended x-ray-absorption fine structure (EXAFS) of molecular and crystalline $KrF_2$ and gas-phase $FeCl_3$ have been obtained by using a modified X$\alpha$ scattered-wave procedure. EXAFS calculations are made in the single-scattering approximation. Effects of multiple scattering near the absorption edge have been investigated by comparing predicted XANES and EXAFS spectra in the near-edge region. Two exchange-correlation potentials, X$\alpha$ and energy-dependent Dirac (ED), were incorporated in the EXAFS calculations. Comparison between experimental and theoretical results confirm that the ED potential is more valid for EXAFS spectra. Molecular field splitting as well as resonance coupling were demonstrated by comparing the theoretical XANES of the isolated $KrF_2$ molecule to that of $FeCl_3$. The single-particle XANES calculation of molecular $FeCl_3$ is compared with the experimental crystalline $FeCl_3$ results of Stern. 37 references, 8 figures, 1 table.

21472 **Theory of resonance ionization spectroscopy.** Payne, M.G.; Hurst, G.S. (Oak Ridge National Lab., TN). pp 183-188 of Analytical laser spectroscopy. Martellucci, S.; Chester, A.N. (eds.). New York, NY; Plenum Publishing Corp. (1985). Contract W-7405-ENG-26.

Resonance Ionization Spectroscopy (RIS) can be defined as a state selective detection process in which pulsed tunable lasers are used to promote transitions from the selected state of the atoms or molecules in question to higher states, one of which will be ionized by the absorption of another photon. The ability to make saturated RIS measurements opens up a wide variety of applications to both basic and applied research. In reviews of RIS the subject was treated generally, including the underlying photophysics applications, the ability to use it to count single atoms, and its applications to measurements in atomic and molecular physics. They view resonance ionization spectroscopy as a specific type of multiphoton ionization in which the goal is to make quantitative measurements of quantum-selected populations in atomic or molecular systems. This goal attained by requiring that the selective excitation steps be resonant in nature and involve only one- or two-photon (only one-photon if at all possible) absorption processes, thereby allowing the entire process to be carried to saturation without loss of spectroscopic selectivity due to laser power induced shifts or broadening.

21473 **Photoionization dynamics of small molecules.** Dehmer, J.L.; Dill, D.; Parr, A.C. (Argonne National Lab., IL). pp 341-408 of Photophysics and photochemistry in the vacuum ultraviolet. McGlynn, S.P. (ed.). Hingham, MA; D. Reidel Publishing Company (1985).

In this paper the recent progress in molecular ionization, with emphasis on photoionization dynamics exhibited by shape and autoionizing resonance phenomena is reviewed. Prototypes, such as $H_2$ and $N_2$, will be used in order to best illustrate the fundamental aspects and the variety of manifestations of these processes. Finally, in Section 4, they present an overview of several other approaches to the study of molecular photoionization dynamics in order to show how they complement those topics emphasized here and to convey, to some extent, the richness of the field.

21474 **Negative-ion states.** Compton, R.N. (Oak Ridge National Lab., TN). pp 261-295 of Photophysics and photochemistry in the vacuum ultraviolet. McGlynn, S.P. (ed.). Hingham, MA; D. Reidel Publishing Company (1985). Contract W-7405-ENG-26.

This review discusses gas-phase negative-ion properties and photo-reactions. Negative ions in the condensed phase have been extensively studied by spectroscopic, electron spin resonance and other techniques. Sanche has recently suggested that shape resonances formed by the capture of an incident electron by its centrifugal angular momentum barrier, could form tight-binding $\pi$ bands in organic insulators. Electronic motion within these bands could account for electrical conductivity in organic solids. Many organic dyes used in dye lasers probably fluoresce and lase between nega-

tive-ion transitions. Although there have been no reports of a negative-ion gas-phase laser, there seems to be no reason why such a device would not be possible. Since most small (3 or 4 atom) negative ions do not possess bound excited states, such a laser would probably involve large organic anions and therefore might afford some moderate tuning capabilities.

21475 **Flowing afterglow study of uranium tetraborohydride.** Babcock, L.M.; Herd, C.R.; Streit, G.E. (Louisiana State Univ., Baton Rouge). *Chemical Physics Letters;* **112**: No. 2, 169-172(30 Nov 1984).

Ionization-fragmentation of uranium(IV) tetraborohydride, $U(BH_4)_4$), by $He^+$ and by $N^+/N_2^+$ yields, predominantly, $U(BH_5)^+$ and $U(B_2H_8)^+$, respectively. Attachment of thermal electrons yields $U(BH_4)_4^-$ and ions of 1, 2, and 3 mass units less. Fluoride transfer with $SF_6^-$, $BF_4^-$, and UF/sub n/$^-$ (n = 5-7) and reactions with other small ions ($O^-$, $O_2^-$, $NO_2^-$, $F^-$, $Cl^-$, $O_2^+$) are described. 14 references, 5 tables.

21476 **k ordering of atomic structure.** Sternheimer, R.M. (Brookhaven National Lab., Upton, NY). pp 1-27 of Progress in atomic spectroscopy. Part C. Beyer, H.J.; Kleinpoppen, H. (eds.). New York, NY; Plenum Publishing Corporation (1984). Contract AC02-76CH00016.

The discovery by the authors of a new ordering principle or extended symmetry in atomic physics (characterized by the quantum number k) in 1976 pertains to the excited-state energy spectra of atoms and ions consisting of a single valence electron outside a core of closed shells. The k ordering applies specifically to medium and heavy atoms and ions, i.e., those with atomic number Z ≧ 11 (Na), so that there is at least one filled p shell in the electron core of the atom or ion. The k-ordering symmetry thus discovered represents in a basic sense the opposite limiting case to the level ordering according to n (n degeneracy) of the hydrogen atom, which will be referred to as the H ordering.

21477 **Interplay between dielectric screening and core hole relaxation in soft x-ray absorption.** Zangwill, A.; Liberman, D.A. (Polytechnic Institute of New York, Brooklyn). *Journal of Physics B: Atomic and Molecular Physics;* **17**: L253-L257(1984).

A convenient approximate prescription for studying the interplay between dielectric polarization effects and the relaxation of outer-shell electrons towards a deep core hole is tested for the case of 3d photoabsorption in xenon. The authors adapt the methods of Amusia and co-workers to a newly developed relativistic time-dependent local density approximation (RTDLDA). The natural choice of a Slater transition-state potential for the RTDLDA calculation produces nearly quantitative agreement with recent absolute cross section data. 24 references, 3 figures.

## 6404 Fluid Physics

*REFER ALSO TO CITATION(S) 21824*

21478 **(SAND—87-8201) Numerical calculation of the drag force induced by natural convection of spheres at low Grashof numbers.** Dudek, D.; Fletcher, T.H. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Chemical Engineering; Sandia National Labs., Livermore, CA (USA)). Feb 1987. Contract AC04-76DR00789. 29p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006791.

When a heated solid sphere is introduced into an ambient fluid, a natural convective flow occurs which results in a drag force on the sphere. This study involves the numerical calculation of both the steady-state and the transient natural convective drag force around spheres at low Grashof numbers. Numerical techniques are taken from Geoola and Cornish. An empirical expression is suggested for the total drag coefficient for Grashof numbers ranging from 4 x $10^{-4}$ to 0.5 and Prandtl number = 0.72: log C/sub DT/ = 1.25 + 0.31 log Gr - 0.097(log Gr)$^2$. The dimensionless time required to reach 90% of the steady-state drag force can be approximated by the second-order polynomial: log t/sub 90%/ = 1.32 - log Gr - 0.11(Gr)$^2$.

21479 **(UCID—20966) A Godunov method for Lagrangian hydrodynamics in 1D.** Crowley, W.P. (Lawrence Livermore National Lab., CA (USA)). 15 Jan 1987. Contract W-7405-ENG-48. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005204.

For transient problems involving strong shocks, the artificial viscosity method has been the standard in numerical hydrodynamics for many years. An alternative approach was suggested by Godunov and it is gaining acceptance. We consider a Godunov method for 1D Lagrangian calculations and show that in the case of a strong shock moving through a nonuniform mesh the Godunov solution is superior to the artificial viscosity solution. For uniform mesh shock problems in spherical geometry the two methods give comparable results. 4 refs., 9 figs.

21480 **Novel laser diagnostic for mercury rare gas low pressure discharges.** Moskowitz, P.E. (GTE Electrical Products, Danvers, Massachusetts 01923). *Applied Physics Letters;* **50**: No. 14, 891-893(6 Apr 1987).

Knowledge of the $Hg(^3P_1)$ spatial distribution in Hg rare gas low pressure discharges is important for understanding radiation transport, and aids in the formulation of discharge models for fluorescent lamps. We report on a novel single laser, two intersecting beams technique, which, for the first time, yields pinpoint information on the radial density profile of excited state mercury in the discharge positive column. Advantages over conventional single beam absorption are discussed, and preliminary data for a discharge containing one isotope ($^{196}Hg$) of mercury and 2.5 Torr argon are presented.

21481 **New solutions for steady bubbles in a Hele-Shaw cell.** Tanveer, S. (Department of Applied Mathematics, California Institute of Technology, Pasadena, California 91125). *Physics of Fluids;* **30**: No. 3, 651-658(Mar 1987).

Exact solutions are presented for steadily moving bubbles in a Hele—Shaw cell when the effect of surface tension is neglected. These solutions form a three-parameter family. For specified area, both the speed of the bubble and the distance of its centroid from the channel centerline remain arbitrary when surface tension is ignored. However, numerical evidence suggests that this twofold arbitrariness is removed by the effect of surface tension, i.e., for given bubble area and surface tension, solutions exist only when the bubble velocity and the centroid distance from the channel centerline attain one or more isolated values. From a limited numerical search, no nonsymmetric solutions could be found; however, a branch of symmetric bubble solutions that was not found in earlier work was found. This branch corresponds to one of the Romero-Vanden-Broeck branch of finger solutions when the bubble size is large. A new procedure for numerical calculations of bubble solutions in the presence of surface tension is presented and is found to work very well for reasonably large bubbles, unlike the previous method of Tanveer [Phys. Fluids 29, 3537 (1986)]. The precise power law dependence of bubble velocity on surface tension for small surface tension is explored for bubbles of different area. Agreement is noted with recent analytical results for a finger.

21482 **Rheological behavior of a suspension of randomly oriented rods.** Graham, A.L.; Mondy, L.A.; Gottlieb, M.; Powell, R.L. (Los Alamos National Laboratory, WX-4, Los Alamos, New Mexico 87545). *Applied Physics Letters;* **50**: No. 3, 127-129(19 Jan 1987). Contract W-7405-ENG-36;AC04-76DP00789.

Falling-ball rheometry is used to study a suspension (volume fraction solids = 0.05) of large, neutrally buoyant rods (length = 3.175 cm, diameter = 0.154 cm) in a viscous Newtonian liquid. We find that all sizes of balls studied (0.65 cm ≦ diameter ≦ 1.90 cm) experience the same continuum that is characterized by a single viscosity which we have measured to be 2.41 times greater than that of the pure suspending liquid. The viscosity increase due to the presence of the rods is over 12 times greater than that observed for a suspension of uniform spheres having the same volume fraction. The results are free of any flow induced clustering and orientation effects and are in reasonable agreement with theoretical predictions for randomly oriented rods.

21483 **Comment on "Fractional statistics of the vortex in two-dimensional superfluids".** Goldin, G.A.; Menikoff, R.; Sharp, D.H. (Departments of Mathematics and Physics, Rutgers University, New Brunswick, New Jersey 08903). *Physical Review Letters;* **58**: No. 2, 174-174(12 Jan 1987).

A Comment on the Letter by R.Y. Chiao, A. Hansen, and A.A. Moulthrop, Phys. Rev. Lett. 54, 1339 (1985).

21484 **Comparison of Green-Kubo and nonequilibrium calculations of the self-diffusion constant of a Lennard-Jones fluid.** Erpenbeck, J.J. (Los Alamos National Laboratory, University of California, Los Alamos, New Mexico 87545). *Physical Review* [*Section*] *A: General Physics;* **35**: No. 1, 218-232(1 Jan 1987).

We apply the so-called "synthetic" nonequilibrium molecular-dynamics method to the calculation of the self-diffusion constant of a Lennard-Jones fluid at a number density of $0.85/\sigma^3$ and a temperature of 1.08 epsilon-c/k/sub B/ (where epsilon-c and $\sigma$ are the energy and length parameters of the potential and k/sub B/ is the Boltzmann constant). By comparing with the Green-Kubo calculation for the same state of the system and for the same number of particles, N, we find the latter calculation to yield more precise values of the self-diffusion constant for a given number of molecular-dynamics time steps. Even at small values of the diffusion current, a nontrivial time is needed for the nonequilibrium calculation to reach the steady state. For larger values of the driving force, the steady-state flow appears to become unstable and evidence of a secondary flow pattern is presented. The presence of these instabilities acts as a limit to the range of the driving force for which the steady-state method can be applied. With increasing N the range of stable values of the diffusion current density decreases. For the Green-Kubo calculations, the N dependence of the self-diffusion constant is found to be anomalous for N = 108, with the 1/N dependence only exhibited for at least 500 particles. The nonequilibrium results, while approximately independent of N for 108 and 500 particles, are found to have a similar anomalous N dependence when we extend the calculations to 1372 particles, thereby bringing the Green-Kubo and nonequilibrium results into agreement in the large-system limit.

21485 **Microstructure characterization and bulk properties of disordered two-phase media.** Torquato, S. (Departments of Mechanical and Aerospace Engineering and of Chemical Engineering, North Carolina State University, Raleigh, North Carolina 27695-7910). *Journal of Statistical Physics;* **45**: No. 3, 843-874(Dec 1986).

A general formalism is developed to statistically characterize the microstructure of porous and other composite media composed of inclusions (particles) distributed throughout a matrix phase (which, in the case of porous media, is the void phase). This is accomplished by introducing a new and general n-point distribution function H/sub n/ and by deriving two series representations of it in terms of the probability density functions that characterize the configuration of particles; quantities that, in principle, are known for the ensemble under consideration. In the special case of an equilibrium ensemble, these two equivalent but topologically different series for the H/sub n/ are generalizations of the Kirkwood—Salsburg and Mayer hierarchies of liquid-state theory for a special mixture of particles described in the text.

21486 **On the energy conversion during geostrophic adjustment.** Ou, H.W. (Lamont-Doherty Geological Observatory of Columbia University, Palisades, NY 10964). *Journal of Physical Oceanography;* **16**: No. 12, 2203-2204(Dec 1986).

It is found that for a continuously stratified fluid which remains so during the geostrophic adjustment, the energy conversion ratio equivalent(equivalent$\Delta$KE/$\Delta$PE) is 1/2, in contrast to the value of 1/3 for a two-layer fluid. Since the two-layer fluid is an asymptotic limit of a continuously stratified fluid, it is deduced that $\gamma$ decreases smoothly from 1/2 to 1/3 when density discontinuities are formed during the adjustment. Furthermore, the total energy released during the adjustment is found to be inversely proportional to the dimensionless horizontal scale (scaled by the baroclinic radius of deformation) characterizing the density variation in the initial state.

21487 **Heating and generation of suprathermal particles at collisionless shocks.** Thomsen, M.F. (Los Alamos National Laboratory, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **144**: No. 1, 157-183(30 Jun 1986). (CONF-8408121—).

From Los Alamos workshop on magnetospheric phenomena in astrophysics; Taos, NM, USA (6 Aug 1984).

Collisionless plasma shocks are different from ordinary collisional fluid shocks in several important respects. They do not in general heat the electrons and ions equally, nor do they produce Maxwellian velocity distributions downstream. Furthermore, they commonly generate suprathermal particles which propagate into the upstream region, giving advance warning of the presence of the shock and providing a "seed" population for further acceleration to high energies. Recent space observations and theory have revealed a great deal about the heating mechanisms which occur in collisionless shocks and about the origin of the various suprathermal particle populations which are found in association with them. An overview of the present understanding of these subjects is presented herein.

21488 **Balance of turbulent energy in the linear wall region of channel flow.** Bernard, P.S.; Berger, B.S. (Univ. of Maryland, College Park). *AIAA (American Institute of Aeronautics and Astronautics) Journal;* **22**: No. 2, 306-308(Feb 1984). Contract AS05-81ER10809.

A description of the energy balance in the wall region of turbulent flow is of importance both in understanding the physical process of turbulent motion and in developing useful closure models. In the present note it is shown that the presence of a very small viscous wall layer is in contradiction with the energy balance calculated by Townsend if it assumed that channel and pipe flows have a similar energy balance in this region.

## 6450 High Energy Physics

*REFER ALSO TO CITATION(S) 21614*

21489 **(INIS-SU—386) JINR rapid communications. Collection.** (Joint Inst. for Nuclear Research, Dubna (USSR)). 1985. 57p. (In Russian). (N—8-85). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780087.

Individual papers in this collection are abstracted separately. (LEW)

21490 **(INIS-SU—395) JINR rapid communications. Collection.** (Joint Inst. for Nuclear Research, Dubna (USSR)). 1986. 52p. (N—16-86). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780088.

Individual papers in this collection are abstracted separately. (LEW)

21491 **(INIS-SU—396) JINR rapid communications. Collection.** (Joint Inst. for Nuclear Research, Dubna (USSR)). 1986. 63p. (In Russian). (N—14-86). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780089.

Individual papers in this collection are abstracted separately. (LEW)

21492 **Popular and unpopular ideas in particle physics.** Perl, M.L. (Stanford Linear Accelerator Center, Stanford, California). *Physics Today;* **39**: No. 12, 24-30(Dec 1986).

As particle physics becomes a deeper but more difficult field, there is too much emphasis on fashionable ideas and the search for anomalies, and too little reward for improving accelerators and detectors.

21493 **Physics at the superconducting super collider.** Appelquist, T.; Gaillard, M.K.; Jackson, J.D. (Yale Univ., New Haven, CT). *American Scientist;* **72**: 151-156(Mar-Apr 1984).

The objective of high-energy physics, or more correctly, elementary particle physics, is to identify the ultimate constituents of matter and to understand the basic forces that bind these constituents to form the world we know. Such questions have been viewed

as fundamental since the earliest times. In this century they have led physicists to create large accelerators such as those at CERN, Europe's high-energy physics laboratory near Geneva, Switzerland, and the facilities at Fermilab, near Chicago. Many questions in high-energy physics can be answered only by probing still deeper into the interior of the nucleon with increasingly energetic particle collisions. For this reason, a 1983 Department of Energy advisory panel recommended the rapid initiation of a new, extremely high energy accelerator. This proposed device, in which two beams of protons would collide head-on, is called the Superconducting Super Collider (SSC). It could be as large as 150 km in circumference. The total cost is not yet certain, but it is hoped that, with a few years of intensive research and development before initiation construction, it can be brought to below $2 billion.

## 6451 Particle Interactions And Properties - Experimental

*REFER ALSO TO CITATION(S) 20997, 21042, 21547*

21494 **(CRN-HE—84-04) Study of charm meson production in Tip and pp interactions at 360 Gev/c.** Etienne, F. (Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires). Feb 1984. 201p. (In French). NTIS (US Sales Only), PC A10/MF A01. File Number DE87750987.

The available energy at accelerators of SPS Type, implies the development of new experimental technics and firet of all their optimization by simulation program. A set of programs has been written to evaluate and improve the performances of the spectrometer EHS (European Hybrid Spectrometer) at C.E.R.N. In 1979, the main components of the spectrometer are ready to be used in an experiment allowing the direct observation of charm decays. Charm D meson production in 360 GeV $\pi^-$p and pp interactions has been studied using the high resolution Hydrogen bubble chamber LEBC and EHS. The production cross sections are computed. The date show evidence for leading quark effect in the Feynman x distribution in the $\pi^-$p sample. The rapidity gap between members of reconstructed charm pairs is small compared to the available rapidity range in the $\pi^-$p sample although no strong correlation is observed between DantiD pairs in the pp sample. Finally the data are compared to other experimental results and checked to the predictions of the models of charm hadro-production in a kinematical region very different from the one of leptons pairs production at high Psub(t) where perturbative QCD applies.

21495 **(EFI—729(44)-84) Total cross section of $\pi$/sup 0/-meson photoproduction on Be, C, O and Al nuclei in the energy range Esub($\gamma$)=(180-650)MeV without charged particles in final state.** Arakelyan, E.A.; Bayatyan, G.L.; Grigoryan, N.K. (Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike, Moscow (USSR)). 1985. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700854.

New experimental results of the measurements of total cross section of $\pi$/sup 0/-meson photoproduction on Be, C, O and Al nuclei for the (180-650) MeV photon energy obtained on the tagged photon beam are reported. The cross sections of $\pi$/sup 0/-meson coherent photoproduction for carbon and oxygen, the carbon nucleus photodisintegration as well as the experimental value of the Levinger factor are estimated. The data are compared with the recent theoretical predictions and experimental values. 15 refs.; 6 figs.

21496 **(EFI—730(45)-84) Total cross section of hadron photoproduction on Be, C, Hsub(2)O and Al nuclei in the energy range Esub($\gamma$)=(200-900) MeV.** (Erevanskij Fizicheskij Inst. (USSR)). 1984. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700855.

New experimental results of the measurement of total cross section of hadron photoproduction on Be, C, H/sub 2/O and Al nuclei for the photon energy of (0.2-0.9) GeV obtained on the tagged photon beam by means of hadron detectors covering the solid angle approximately $4\pi$ are reported. The results are compared with the available data on total cross section of hadron photoproduction. For the oxygen nucleus the comparison is carried out with the theoretical predictions for the photon energy up to 400 MeV. 14 refs.; 3 figs.; 1 tab.

21497 **(IFVE—85-21) New results on properties of charmed D/sup 0/ mesons produced in $\pi$/sup -/p interactions at 360 GeV/c.** Agyular-Benite, M.; Allison, V.V.; Bagg, V.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 14p. (In Russian). (OEIPK-NA—27). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700891.

The following new results: mean lifetime tau=(3.5sub(0.9)syp(+1.4)) x 10sup(-13) s; inclusive cross section $\sigma$(xsub(F) > 0)=10.3 +- 3.5 $\mu$b, relative probability of four particle charged mode of decays Br(Dsup(0) -> Ksup(+-)$\pi$sup(+-)$\pi$sup(+)$\pi$sup(-)=(7.1 +- 2.5)% are obtained based on analysis of 22 four-prong decays of D/sub 0//anti D/sub 0/-mesons produced in $\pi$/sup -/$\pi$ interactions at 360 GeV/c. 10 refs.: 3 figs.; 1 tab.

21498 **(IFVE-OEIPK—85-65) Inclusive Ksub(s)sup(0) and $\Lambda$ and anti$\Lambda$ production in 360 Gev/c pp interactions using the European Hybrid Spectrometer.** Asai, M.; Bagg, V.M.; Bailli, D.L. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 24p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700895.

Characteristics of Ksub(s)sup(0)-meson and $\Lambda$- and anti $\Lambda$-hyperon production in PP interactions at 360 GeV/c are investigated in the facility comprising a rapid-cycling bubble chamber (RCBC) and European hybrid spectrometer. Data on total and differential cross sections and mean multiplicities in production of neutral strange particles are presented. Estimations of $\Lambda$- and anti $\Lambda$-hyperon polarization, estimation of cross sections of Ksub(s)sup(0), LAMBDA and anti LAMBDA diffraction production are obtained. Comparison with inclusive production of charmed particles is carried out. 25 refs.; 13 figs.

21499 **(IFVE-OEIPK—85-90) Associated production of the Ksup(*+)(890) or rho/sup 0/ with other particles in the K/sup +/p inclusive reactions at 32 GeV/c.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 16p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700896.

After introduced modifications the Lund quark-fragmentation model on the whole successfully describes both large totality of data obtained in the considered experiment and published data on associative production of resonances with other particles or resonances. 18 refs.; 8 figs.

21500 **(IFVE-ONF—84-191) Study on the anti$\nu$N -> $\mu$/sup +/rho/sup -/N reaction at high energy.** Ammosov, V.V.; Gapienko, V.A.; Gapienko, G.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1984. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700900.

Based on the data obtained with the FNAL 15-th bubble chamber a study of the reaction anti$\nu$N -> $\mu$/sup +/rho/sup -/N going with the cross section of (1.3 + 0.5) x 10/sup -39/ cm/sup 2/ has been performed. A comparison with predictions of the vector meson dominance model is presented. The obtained value of cross section of the anti$\nu$N -> $\mu$/sup +/rho/sup -/N reaction, when comparing with the available data on single-particle production of rho mesons in neutrino interactions, enters rather well the general picture of model predictions of the vector meson dominance. 10 refs; 2 figs.

21501 **(IFVE-ONF—85-109) Study on the cumulative proton production in neutrino-nuclear interactions.** Ammosov, V.V.; Baranov, D.S.; Ivanilov, A.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 15p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700901.

Submitted to the journal Sov. J. Nucl. Phys. .

Properties of cumulative proton production in neutrino (antineutrino) interactions with Freon nuclei in SKAT bubble chamber experiment are studied. The results obtained are compared with calculations in the framework of the cascade model. The production of cumulative protons are shown to be mainly the effects of secondary intranuclear rescattering, but not primary interactions. An account for two-nuclear absorption of slow $\pi$-mesons in a nucleus is very important for explanation of experimental results. 26 refs.; 7 figs.; 1 tab.

21502 **(IFVE-OTF—85-67) On the preasymptotic mode in hadron elastic scattering.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700910.

Submitted to the journal Nuovo Cimento.

The preasymptotic behaviour of total and elastic cross sections in proton-proton and kaon plus proton interactions is considered on the basis of the quark model for U-matrix. For the total cross sections of interactions of different hadron pairs the relations have been obtained which allow to explain the relative values of the cross sections on the basis of the quark structure of initial particles. 10 refs.; 4 figs.

21503 (INIS-SU—376, pp 24-27) **On some possibilities of supernuclei production.** Starkov, N.I.; Tsarev, V.A. (Moskovskij Gosudarstvennyj Univ., USSR. Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki). 1984. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700079.

Kratkie Soobshcheniya po Fizike. No. 12.

In Quantum radiophysics. Collection.

Some possible mechanisms of charmed supernuclei production are considered and their yields are evaluated. For comparison evaluations of hypernuclei production are given. 6 refs.; 4 figs.

21504 (INIS-SU—395, pp 24-32) **Four-dimensional jets as universal characteristics of multiple particle production.** Baldin, A.M.; Batyunya, B.V.; Gramenitskij, I.M.; Grishin, V.G.; Didenko, L.A.; Kuznetsov, A.A.; Metreveli, Z.V. (Joint Inst. for Nuclear Research, Dubna, USSR. Lab. of High Energy). 1986. NTIS (US Sales Only), PC A04/MF A01. File Number DE87780088. (N—16-86).

In JINR rapid communications. Collection.

A new definition of the jets as clusters in the four-velocity space has been used to make an invariant analysis of multiple production in pp, anti pp, $\pi$/sup -/p, $\pi$/sup -/C, pC and pTa collisions at energies from 6 to 205 GeV. It has been observed that the characteristics of four-dimensional jets are universal, i.e. independent of neither the properties, nor the energy of colliding particles for P>=22 GeV/c. 11 refs.; 2 figs.; 2 tabs.

21505 **(ISN—85-44) Neutrino oscillation effect observed near a Bugey PWR reactor.** Hoummada, A. (Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires). Sep 1985. 176p. (In French). NTIS (US Sales Only), PC A09/MF A01. File Number DE87750985.

The energy spectrum of electron antineutrinos has been measured at two distances, 13.60 and 18.30 meters from the core of a PWR power reactor at Bugey. About 100,000 neutrino-induced events were detected by a detector based on the inverse Beta decay reaction antivsub(e) + p $\rightarrow$ n + $e^+$. We have observed a neutrino disappearance of 8.2% +- 1.4% stat +- 26% syst at the second position (18.30 m) as compared to the first position. An interpretation of this integrated counting difference between the two positions by a simple two-neutrino oscillation scheme exclude the no-oscillation case at the 2.3$\sigma$ Level. The parameters of neutrino oscillation deduced from our analysis are: $\sin^2 2\text{theta} = 0.25$ and $\text{deltam}^2 = 0.20$ $ev^2$.

21506 **(ITEF—117(1985)) Disintegration of photoemulsion nuclei in small angle inelastic scattering of muons with 32 GeV momentum. Fast proton emission.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 20p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700976.

Energy and angular distributions of fast protons, T>=30 MeV, estimated in the events of 32 GeV momentum muon inelastic scattering by photoemulsion nuclei at small values of inelasticity (< or approximately 0.1) and transfer four-momentum (Q/sup 2/ approximately equal to 0.1 GeV/sup 2/, x approximately 0.01) are analyzed. Comparison of characteristics of fast protons, emitted in muonic events and in the events of nucleus disintegrated by fast $\gamma$, $\pi$, p-particles, pionts to the difference at the level of approximately 2.5 errors, in angular dependence of proton energy spectrum inclination parameters and in its value for protons in forward hemisphere. The results obtained correspond completely to the data of experiments on pion total absorption by nuclei. 19 refs.; 6 figs.; 4 tabs.

21507 **(ITEF—136(1985)) Strong interaction: experiments from 1982 to 1984. Heavy quarks.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 20p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700979.

Experimental data stored in 1982-1984 on detection and precise measurement of parameters of exotic meson resonances and heavy quark states are reviewed. Masses and channels of F meson decays, pseudoscalar charmonium (/sup 1/S/sub 0/-state), bottomonium, sup(3)Psub(j)- and quasibound /sup 3/S/sub 1/-states of the quark-antiquark pair banti b, studied in different laboratories of the world are considered. Data on precise measurements of mass spectra of $\gamma$- and psi-families, etasub(c) and etasub(b)-states, chisub(c) and chisub(b)-states in panti p- and eanti e-annihilations are analyzed. A scheme of bound bottomonium states is given. The published results of CUSB, CLEO, CRYSTALL, BALL, CERN-ISR and other groups are tabulated. 38 refs.; 9 figs.; 1 tab.

21508 **(LA-UR—86-3228) Search for rare muon and pion decay modes with the Crystal Box detector.** Hoffman, C.M.; Bolton, R.D.; Bowman, J.D.; Cooper, M.D.; Frank, J.S.; Hallin, A.L.; Heusi, P.; Hogan, G.E.; Mariam, F.G.; Matis, H.S.;. (Los Alamos National Lab., NM (USA); Stanford Univ., CA (USA); Chicago Univ., IL (USA); Temple Univ., Philadelphia, PA (USA)). 1986. Contract W-7405-ENG-36. 5p. (CONF-860701—72). NTIS, PC A02/MF A01; GPO Dep. File Number DE87000155.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

New experimental upper limits for the branching ratios of the lepton-family-number nonconserving decays $\mu^+ \rightarrow e^+\gamma$ and $\mu^+ \rightarrow e^+\gamma\gamma$ are presented. A new determination of $\gamma$, the ratio of pion axial-vector to vector form factors, from radiative pion decay is also reported. These results are from data taken with the Crystal Box detector at LAMPF.

21509 **(LAL—86-06) Production and study of the properties of intermediate vector bosons - $UA_2$ experiment.** Iconomidou-Fayard, L. (Paris-11 Univ., 91 - Orsay (France). Lab. de l'Accelerateur Lineaire). Mar 1986. 171p. (In French). NTIS (US Sales Only), PC A08/MF A01. File Number DE87750988.

This thesis presents some results concerning the properties of IVB's detected by the UA2 experiment. The "electron-identification" criteria are discussed and the final samples of W's and Z's, corresponding to a total integrated luminosity of 863 $nb^{-1}$, are given. A particular study of the longitudinal motion of bosons has been done and the momentum distribution of the "parent-partons" has been evaluated. In the W's center of mass frame the angular distribution of the outgoing changed lepton (electron or positron) is in good agreement with the theoretical shape expected from the Standard Model and QCD corrections. The cross-sections of the processes W $\rightarrow e\nu$ and Z $\rightarrow e^+e^-$ and the masses of IVB's are

measured. The values of sin²thetasub(W) and rho are evaluated. A good agreement with the standard model is observed.

21510 **(SLAC-PUB—3194) Jet production and quark fragmentation results from PEP.** Hanson, G.G. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Aug 1983. Contract AC03-76SF00515. 5p. NTIS.

From International europhysics conference on high energy physics; Brighton, England (20-27 Jul 1983).

Results on jet production and quark fragmentation are presented from the five detectors at the PEP $e^{+-}$ storage ring at the Stanford Linear Accelerator Center: DELCO (Caltech-SLAC-Stanford), HRS (Argonne-Indiana-LBL-Michigan-Purdue-SLAC), MAC (Colorado-Frascati-Houston-Northeastern-SLAC-Stanford-Utah-Wisconsin), MARK II (SLAC-LBL-Harvard), and TPC (LBL-Johns Hopkins-UCLA-UC Riverside-Yale). All data were taken at a center-of-mass energy (E/sub c.m./) of 29 GeV. The topics discussed are particle identification, charge and multiplicity correlations, energy correlation asymmetry, D* and D production and fragmentation, and heavy quark fragmentation results from inclusive lepton studies.

21511 **(SLAC-PUB—3206) Light quark spectroscopy.** Aston, D. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Sep 1983. Contract AC03-76SF00515. 5p. NTIS.

From International europhysics conference on high energy physics; Brighton, England (20-27 Jul 1983).

Meson spectra obtained from various interactions, including electron-positron interactions, pion minus-proton interactions and photoproduction, are reviewed. Examples of scalar and vector meson spectra are shown and partial wave analysis is discussed. While the main features of the meson spectrum are clear, much work needs to be done to understand underlying states if the existence of gluonic hadrons predicted by QCD is to be established.

21512 **(SLAC-PUB—4153) D/sub s/ production data from Mark III.** Toki, W. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Dec 1986. Contract AC03-76SF00515. 11p. (CONF-860736—7). NTIS, PC A02/MF A01; GPO Dep. File Number DE87004899.

From SLAC summer institute on particle physics; Stanford, CA, USA (29 Jul 1986).

Preliminary results on D/sub s/ decays from the Mark III at SPEAR are presented. The data were taken at a $e^+e^-$ center of mass energy of $\sqrt{s}$ = 4.14 GeV with a total integrated luminosity of 6.3 +- 0.46 pb. The decay $e^+e^- \rightarrow$ D/sub s/D/sub s/*, D/sub s/ $\rightarrow$ phi $\pi$ is observed, yielding a D/sub s/ mass of 1973 +- 4 +- 4 MeV/c² and a D/sub s/* mass of 2110.8 +- 1.9 +- 3.2 MeV/c² with a rate of $\sigma(e^+e^- \rightarrow$ D/sub s/sup $^+$-/D/sub s/*/sup -+/, D/sub s/*/sup -+/ $\rightarrow \gamma$D/sub s/sup -+/ . B(D/sub s/$^+ \rightarrow$ phi $\pi$/sup +-/) = 36 +- 7 +- 13 pb. There is evidence for two other modes, D/sub s/sup +-/ $\rightarrow$ K*$^0$K/sup +-/ and D/sub s/sup +-/ $\rightarrow$ K/sub s/$^0$K/sup +-/, which are observed with rates of $\sigma(e^+e^- \rightarrow$ D/sub s/D/sub s/*) . B(D/sub s/$^+ \rightarrow$ K*$^0$K/sup +-/) = 31 +- 16 +- 11 pb and $\sigma(e^+e^- \rightarrow$ D/sub s/D/sub s/*) . B(D/sub s/sup +-/ $\rightarrow$ K/sub s/$^0$K/sup +-) = 16 +- 3 +- 5 pb.

21513 **Analyzing power and transversity cross sections for $\pi$ip and $\pi^-$p elastic scattering from 471 to 687 MeV/c.** Mokhtari, A.; Eichon, A.D.; Kim, G.J.; Nefkens, B.M.K.; Wightman, J.A.; Fitzgerald, D.H.; Briscoe, W.J.; Sadler, M.E. (Department of Physics, University of California, Los Angeles, California 90024). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 3, 810-823(1 Feb 1987).

We have obtained precise data on the analyzing power for $\pi^+$p and $\pi^-$p elastic scattering at 471, 547, 625, and 687 MeV/c using a transversely polarized target. Using our previously measured differential cross sections at the above beam momenta, we have determined the transversity cross sections and the bounds of the isospin triangle inequalities. Comparisons are made with the results of existing partial wave analyses by the Karlsruhe-Helsinki, Carnegie-Mellon University—LBL, and VPI groups. The $\pi^+$ predictions are in acceptable agreement with our data, while the agreement is less acceptable for $\pi^-$.

21514 **Measurement of the branching fractions of the tau lepton using a tagged sample of tau decays.** Burchat, P.R.; Feldman, G.J.; Barklow, T.; Boyarski, A.M.; Burke, D.L.; Dorfan, J.M.; Gladney, L.; Hanson, G.; Hayes, K.; Hollebeek, R.J. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 1, 27-41(1 Jan 1987). Contract AC03-76SF00515.

The branching fractions for the major decay modes of the tau lepton are measured from a sample of tagged tau decays selected from tau$^+$tau$^-$ pairs produced in $e^+e^-$ annihilation. The decay products of one member of the tau$^+$tau$^-$ pair are used to identify the event. The opposite member of the pair is then included in the sample if it satisfies an invariant-mass cut and a charged-multiplicity cut. In this way, we attempt to select an unbiased sample of tau decays. The sample is divided into categories based on charged- and neutral-particle multiplicities, and charged-particle identification. The branching fractions are measured simultaneously, with an unfold technique and a maximum-likelihood fit, with the sum of the branching fractions constrained to be unity.

21515 **Inclusive B-meson decays into charm.** Bortoletto, D.; Chen, A.; Garren, L.; Goldberg, M.; Holmes, R.; Horwitz, N.; Jawahery, A.; Lubrano, P.; Moneti, G.C.; Sharma, V.; and others. (Syracuse University, Syracuse, New York 13210). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 1, 19-26(1 Jan 1987).

We have measured the B-meson decay fractions into $D^0$, $D^+$, and D/sup */$^+$ mesons to be 0.39 +- 0.05 +- 0.04, 0.17 +- 0.04 +- 0.04, and 0.22 +- 0.04/sub -0.04//sup +0.07/, respectively, if we use the $D^0 \rightarrow K^-\pi^+$ and $D^+ \rightarrow K^-\pi^+\pi^+$ branching ratios determined by the Mark III Collaboration. These results suggest that B decay to noncharm final states is substantial. We also find that B decay to spin-1 D/sup */ mesons dominates over direct decay to spin-0 D mesons and that the ratio (D$^0$+D/sup */$^0$)/(D$^+$+D/sup */$^+$) is consistent with unity.

21516 **Nucleon-nucleon partial-wave analysis to 1100 MeV.** Arndt, R.A.; Hyslop J.S. III; Roper, L.D. (Department of Physics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 1, 128-144(1 Jan 1987).

Comprehensive analyses of nucleon-nucleon elastic-scattering data below 1100 MeV laboratory kinetic energy are presented. The data base from which an energy-dependent solution and 22 single-energy solutions are obtained consists of 7223 pp and 5474 np data. A resonancelike structure is found to occur in the $^1D_2$, $^3F_3$, $^3P_2$-$^3F_3$, and $^3F_4$-$^3H_4$ partial waves; this behavior is associated with poles in the complex energy plane. The pole positions and residues are obtained by analytic continuation of the "production" piece of the T matrix obtained in the energy-dependent solution. The new phases differ somewhat from previously published VPI&SU solutions, especially in I = 0 waves above 500 MeV, where np data are very sparse. The partial waves are, however, based upon a significantly larger data base and reflect correspondingly smaller errors. The full data base and solution files can be obtained through a computer scattering analysis interactive dial-in (SAID) system at VPI&SU, which also exists at many institutions around the world and which can be transferred to any site with a suitable computer system. The SAID system can be used to modify solutions, plan experiments, and obtain any of the multitude of predictions which derive from partial-wave analyses of the world data base.

21517 **Search for the rare decay $\mu i \rightarrow e^+\gamma\gamma$.** Grosnick, D.; Wright, S.C.; Bolton, R.D.; Cooper, M.D.; Frank, J.S.; Hallin, A.L.; Heusi, P.A.; Hoffman, C.M.; Hogan, G.E.; Mariam, F.G.; and others. (University of Chicago, Chicago, Illinois 60637). *Physical Review Letters;* **57**: No. 26, 3241-3244(29 Dec 1986).

A new experimental search with the Crystal Box detector shows no evidence for the lepton-family-number—nonconserving decay $\mu^+ \rightarrow e^+\gamma\gamma$. This corresponds to an upper limit for the branching ratio of $\Gamma(\mu \rightarrow e\gamma\gamma)/\Gamma(\mu \rightarrow e\nu\text{nu-bar}) < 7.2 \times 10$/sup -1/

(90% confidence level), an improvement of more than 2 orders of magnitude in sensitivity.

**21518 Search for high-mass narrow resonances in virtual photon-photon interactions.** Aihara, H.; Alston-Garnjost, M.; Avery, R.E.; Barbaro-Galtieri, A.; Barker, A.R.; Barnes, A.V.; Barnett, B.A.; Bauer, D.A.; Bengtsson, H.h.; Bintinger, D.L.; and others. (Lawrence Berkeley Laboratory, Berkeley, California 94720). *Physical Review Letters;* **57**: No. 26, 3245-3248(29 Dec 1986).

We report on the first search with virtual photon-photon collisions for narrow, neutral resonances with even C parity in the mass range $4.5<W<19$ GeV. The data were obtained via the process $e^+e^-\rightarrow e^+e^-\gamma/sup\ */\gamma/sup\ */\rightarrow e^+e^-R$ with both the scattered $e^+$ and $e^-$ detected. We find upper limits (95% confidence level) for the partial decay width of a resonance into two photons, ranging from 50 keV at W = 4.5 GeV to 10 MeV at W = 19 GeV. These limits constrain theoretical models involving neutral composite bosons.

**21519 Observation of direct photons in Upsilon and Upsilon' decays and determination of the QCD scale parameter.** Schamberger, R.D.; Horstkotte, J.E.; Klopfenstein, C.; Lee-Franzini, J.; Sivertz, M.; Spencer, L.J.; Franzini, P.; Son, D.; Youssef, S.; Tuts, P.M.; Zhao, T. (State Univ. of New York, Stony Brook). *Physics Letters* [*Section*] *B;* **138B**: No. 1-3, 225-229(12 Apr 1984). Contract AS05-77ER05490.

Using the CUSB detector, the authors have measured the high energy direct photon spectrum from Upsilon and Upsilon' decays. These photons are assumed to arise from decays Upsilon, Upsilon' $\rightarrow \gamma gg$. The authors determine the ratio Gamma($\gamma gg$)/Gamma(ggg) to be 0.0299 +/- 0.0059 for the Upsilon and 0.0337 +/- 0.0114 for the Upsilon'. From these results the authors obtain: $\alpha/sub\ s/ = 0.226/sub\ -0.042//sup\ +0.067/$, $\Lambda/sub\ MS\ vector/ = 116/sub\ -57//sup\ +105/$ MeV for Upsilon $\rightarrow \gamma gg$, and $\alpha/sub\ s/ = 0.197/sub\ -0.055//sup\ +0.123/$, $\Lambda/sub\ MS\ vector/ = 80/sub\ -59//sup\ +195/$ MeV for Upsilon' $\rightarrow \gamma gg$. 18 references, 4 figures.

**21520 Observation of the anomalous nuclear enhancement in the neutral energy spectrum in the central region of $\alpha$-$\alpha$ interactions at $\sqrt{s}$ = 124 GeV at the CERN ISR.** Angelis, A.L.S.; Basini, G.; Besch, H.J.; Breedon, R.E.; Camilleri, L.; Chapin, T.J.; Chasman, C.; Cool, R.L.; Cox, P.T.; von Gagern, C.; Grosso-Pilcher, C. (Brookhaven National Lab., Upton, NY). *Nuclear Physics* [*Section*] *A;* **A418**: 321c-326c(1984).

Preliminary results are presented for the total neutral energy spectra in the central region from $\alpha\alpha$ and pp collisions at center-of-mass energies of $\sqrt{s}$ = 31 SeV per nucleon pair. The data were collected in the recent light ion run at the CERN ISR during August 1983. The $\alpha\alpha$ luminosity achieved in this run was $10^{30}$ cm$^{-2}$ s$^{-1}$. The ratio of the $\alpha\alpha$ cross section to the pp cross section rises dramatically with increasing E°/sub TOT/ from a factor of 30 at E°/sub TOT/ of 5 GeV to a factor of 10,000 at E°/sub TOT/ of 16.5 GeV. The existence of $\alpha\alpha$ data beyond the nucleon-nucleon kinematic limit indicates the inadequacy of the parameterization $R(\alpha\alpha/pp) = (A_1A_2)/sup\ \alpha/$ for the E°/subTOT/ spectrum.

## 6452 Particle Interactions And Properties - Theoretical

*REFER ALSO TO CITATION(S) 21440, 21609, 21676, 21686*

**21521 (BONN-HE—86-15) Towards relativistic electromagnetic baryon couplings motivated by QCD.** Schroeder, H.; Pfeil, W.; Rollnik, H. (Bonn Univ. (Germany, F.R.). Physikalisches Inst.). Jul 1986. 25p. (CONF-8606164—3). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751280.

From 8. international seminar on high energy physics problems; Dubna, USSR (19 Jun 1986).

The QCD-motivated quarkmodels for hadrons use hyperfine interactions which are basically of relativistic origin (order (v/c)/sup 2/). Therefore, we have studied systematically the photonquark interactions up to order (1/c)/sup 3/ and applied the results to the electromagnetic transition amplitudes and formfactor for hadrons consisting of light quarks. Based on the formalism developed by Foldy et al. we calculated the single quark, the potential dependent and the center of mass contributions to the $\gamma$-quark couplings. The resulting effective photon-quark Hamiltonian has a complicated spin structure which contains in addition to the known four single particle amplitudes A, B, C, D ten new pieces which describe photon-two particle couplings. By calculating matrix elements of this Hamiltonian with Isgur-Karl quark wave functions we obtained transition formfactors and photo-production amplitudes for all isobars with oscillator quantum numbers N=0, 1 and 2. We found rather large relativistic contributions up to 25% even for smaller Q/sup 2/-values. Qualitatively the strong decrease of the non-relativistic formfactor is essentially flattened thus compensating in part the effect of oscillator wave-functions and bringing our results nearer to the experimental values.

**21522 (CEA-CONF—8493) Perturbative QCD and jets.** Mueller, A.H. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Mar 1986. 20p. (CONF-8603119—15; CEA-SPhT—86-77). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750983.

From 21. Rencontre de Moriond: strong interactions and gauge theories conference; Les Arcs, France (16 Mar 1986).

A brief review of some of the recent progress in perturbative QCD is given (heavy quark production, small-x physics, minijets and related topics, classical simulations in high energy reactions, coherence and the string effect).

**21523 (CEA-CONF—8579) Reactor antineutrinos and underground detectors.** Lagage, P.O. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Jul 1986. 5p. (CONF-860741—22). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751021.

From International symposium on weak and electromagnetic interactions in nuclei; Heidelberg, F.R. Germany (1 Jul 1986).

This paper presents briefly the antineutrino background from far away nuclear reactors in various underground laboratories. The total number of counts induced per year by reactor antivsub(e) charged current interactions, and the cross section of electron elastic scattering interactions are given with curves. A comparison between reactor and other sources is made. Finally, reactor antivsub(e) oscillations and large underground detectors are discussed. 16 refs.

**21524 (DOE/ER/40272—18) Majorana neutrino signatures of heavy Z bosons at the SSC [Superconducting Super Collider].** Duncan, M.J.; Ruiz-Altaba, M. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics; Florida Univ., Gainesville (USA). Dept. of Physics). 23 Jun 1986. Contract FG05-86ER40272. 12p. (UPR—0308-T; UFTP—86-18; CONF-8606215—34). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005676.

From Summer study on the physics of the superconducting super collider; Snowmass, CO, USA (23 Jun 1986).

If a heavy Z' boson of an extra U(1) group is discovered, then we should expect a large fraction of its decays to be into two heavy Majorana neutrinos. The most distinct property of Majorana neutrinos is that they can decay to states of opposite charge content. The pair of neutrinos is therefore a source of dileptons, and we show that a characteristic feature of these signatures is that the like- and opposite-sign dilepton distributions are the same.

**21525 (DOE/ER/40272—24) Reconstructing W and Z boson invariant masses from jets.** Field, R.D. (Florida Univ., Gainesville (USA). Dept. of Physics). 23 Jun 1986. Contract FG05-86ER40272. 41p. (UFTP—86-24; CONF-8606215—36). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005678.

From Summer study on the physics of the superconducting super collider; Snowmass, CO, USA (23 Jun 1986).

A QCD parton-shower Monte Carlo model is used to simulate the production and decay of W bosons in hadron-hadron collisions and the events are analyzed using jet and cluster techniques in an attempt to reconstruct the invariant mass of the W bosons that

decay hadronically W->q anti q. It is found that jet-jet mass resolutions are limited not by experimental factors such as calorimeter grid size but by the inherent uncertainty in the true origin of the particles forming the jets. The best one can do on a pure sample of W->q anti q events at CM energies of 540 or 1600 GeV is a jet-jet mass width of about 30 GeV. Fictitious heavy narrow W' bosons are generated at 1600 GeV and 40 TeV. Both jet and cluster techniques yield a similar mass width of about 50 GeV for the W'(336)->q anti q events at 1600 GeV and a width of about 150 GeV for the W'(1000)->q anti q events at 40 TeV. Cluster techniques seem to work better in analyzing large transverse momentum W bosons (approximately 200 GeV) produced in pairs at the SSC CM energy of 40 TeV and yield a width of about 20 GeV. The results are equally valid for Z or Z' bosons of the corresponding mass.

21526 **(DOE/ER/40272—28) The axion couplings.** Sikivie, P. (Florida Univ., Gainesville (USA). Dept. of Physics). 1986. Contract FG05-86ER40272. 28p. (UFTP—86-28; CONF-8507149—1; CONF-8606261—1). NTIS MF A01; 2; GPO Dep. File Number DE87005680.

From Les Houches summer school on the architecture of fundamental interactions of short distances; Les Houches, France (1 Jul 1985).

A pedagogical derivation of the couplings of the axion to quarks, leptons, photons, gluons and nucleons is given. The effective Lagrangian method is used throughout. The results are applicable to all axion models.

21527 **(EFI—731(46)-84) Form factors of mesons and meson resonances at small and intermediate momentum transfers Q/sup 2/ in the relativistic quark model.** (Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike, Moscow (USSR)). 1984. 30p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700856.

The structure of the pion wave function is investigated in the relativistic quark model as well as the predictions for the form factors of both $\pi$, rho, A/sub 1/-mesons, $\omega \to \pi\gamma$ and A/sub 1/ -> $\pi\gamma$ transitions are obtained. The results for the form factors of $\pi$, A/sub 1/-mesons, $\omega \to \pi\gamma$ transition and the form factor of A/sub 1/ -> $\pi\gamma$ transition are in good qualitative agreement with the QCD dispersion sum rule predictions. The results for the rho-meson form factors approximately twice as much exceed the predictions of the QCD sum rules. 19 refs.; 7 figs.

21528 **(EFI—739(54)-84) Exotic hyperons in sum rules for Reggeons scattering on particles.** (Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike, Moscow (USSR)). 1984. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700857.

The superconvergent sum rules (SSR) for the Reggeon-particle scattering amplitudes are applied to the investigation of interaction of hyperons with rho, A/sub 2/,$\pi$-Reggeons. It is shown that from the sum rules for the I1 Reggeon scattering on lambda-hyperons folows the existence of $\sigma$ and $\sigma$(1385) hyperons. The SSR prediction for the $\sigma$(1385) ->$\Lambda\pi$ and $\sigma$ (1385)->$\sigma\pi$ decays ratio agrees well with experiment. The successive application of the SSR method to I=1 Reggeon scattering on hyperons with strangeness S=-1 leads to the prediction of the exotic states with I>=2. In particular, for I=2, two resonances with spins S=5/2,3/2 and positive parity are predicted. The properties of these resonances are analyzed. The experiments to search for them in backward scattering and in $\sigma$-beam processes are proposed. The theoretical estimations of these processes cross sections are given. The application of the SSR to the processes of I=1 Reggeon scattering on hyperons with strangeness S=-2 and -3 is discussed. 18 refs.; 2 figs.; 1 tab.

21529 **(IFVE-ONF—85-111) Radiative decays of charged kaons in the vector dominance model with account of chiral anomalies.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 22p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700902.

The kaon radiative decay K/sup +/ -> $\pi$/sup +/$\pi$sup(o)$\nu$ and K/sup +/ -> $\pi$/sup +/$\nu\nu$ have been considered in the vector meson dominance approach with account for the Wess-Zumino-Witten anomaly. The K/sup +/ -> $\pi$/sup +/$\pi$sup(o)$\nu$ direct emissian amplitude and K/sup +/ -> $\pi$/sup +/$\nu\nu$ decay width are shown to be dominated by chiral anomalies.The contribution to the decay is also made by charged pion polarizability. In the frame of the chiral model different contributions into kaon decay amplitudes have been singled out as well as their branching ratio has been evaluated. The experimental consequence of the theory, in particular, the possibility for the CP violation effects search in K/sup +-/ -> $\pi$/sup +-/$\pi$sup(o)$\nu$ decays have been discussed. 35 refs.; 1 fig.

21530 **(IFVE-ONF/FTO/PK—84-109) Violation of CP-invariance and e/$\mu$/tau-universality in horizontal gauge interactions.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1984. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700903.

The principal possibilities are considered for observing the effects associated with the hypothetical universal "horizontal" interaction. The latter allows to solve, from the common point of view, the problems dialing with the violation of CP invariance and quark-leptonic generations symmetry (e/$\mu$tau-universality). It is shown that the effect of the simultaneous violation of CP invariance and the horizontal symmetry of quark-leptonic generations (and, correspondingly, the e/$\mu$tau-universality), which are caused by the "horizontal" interaction, may be detected, due to its superweak nature, first of all in K/sup 0/-anti K/sup 0/, D/sup 0/-antiD/sup 0/, B/sup 0/-anti B/sup 0/ oscillations as well as in such decays as Ksub(L)sup(0) -> anti $\mu$e; $\mu$ enti e Ksup(+-) -> $\pi$sup(+-)($\mu$e=; D/sup 0/ -> $\mu$ anti e, $\mu$e; B/sup 0/ -> tau/sup +/e/sup -/,.... In this the charge assymmetry of leptonic pairs ($\mu$/sup +/e/sup -/ or $\mu$/sup -/e/sup +/) is conditioned by CP violation not only in reactions with K/sup 0/(D/sup 0/)-mesons, but also in the leptonic sector of the Lagrangian. 33 refs.; 4 figs.

21531 **(IFVE-OTF—85-14) Multiplicity distributions in dual parton model.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700907.

Submitted to the journal Sov. J. Nucl. Phys. .

The new technique earlier proposed by the authors for hadron production in a string, which takes explicitly into account valence nature of string-forming quarks, is used for calculation of the multiplicity distributions. Such a consideration is shown to improve considerably the description of low-energy multiplicity distributions of charged particles. For superhigh energies, the contribution from the string ends becomes negligible. However, in this case one has to take into account multi-pomeron contributions. 8 refs.; 11 figs.

21532 **(IFVE-OTF—85-48) Gluon structure of hadrons and rise of total cross sections at high energies.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 5p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700908.

The cause of the rise of total cross-sections is discussed from the point of view of their gluon structure. It is pointed out processes of hadron interactions, is evidently, the most natural explanation of the universal character of inclusive distributions discussed for a number of years. 7 refs.

21533 **(IFVE-OTF—85-57) Structure functions and leptonic widths of heavy mesons.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1985. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700909.

The structure functions of mesons containing heavy quarks are related to the values of the wave functions of these mesons. The leptonic decay widths of the mesons are calculated. 6 refs.; 1 fig.

**21534 (IFVE-OTF—85-179) Magnetic moment of W boson in the process e/sup +/+e/sup -/ -> γ + νsub(i) + anti νsub(i): tests of Yang-Mills couplings in the vertex (Wsub( γ)W).** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700912.

Possibilities to measure W-boron magnetic moment before these particles are really produced, have been considered. For this purpose the cross section for the process e/sup +/e/sup -/ -> γνsub(i)anti νsub(i) (where i=e, μ, tay,...) has been calculated with an account for the diagram (3W) which contains W-boson gyromagnetic ratio gsub(W). The results obtained are valid for not very high energies, since the calculations have been made only in the first order of (s/2Msub(W)sup(2)). 8 refs.; 2 figs.; 1 tab.

**21535 (INIS-SU—386, pp 5-17) Relativistic invariant analysis of correlation phenomena in multiple production processes.** Baldin, A.M.; Didenko, L.A. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780087. (N—8-85).

In JINR rapid communications. Collection.

A new relativistic invariant method is suggested for the study of correlation phenomena in multiple production processes. The correlation analysis extensively used in literature, which employs, e.g., the longitudinal rapidity variables, is shown to be inconsistent because it neglects the links between the kinematic variables which are of a purely geometric nature. Different two-particle correlations of pions and nuclei extracted from experiment were found to be identical and, in the asymptotic, to be coincident. This is in agreement with the general properties of the hadron distribution formulated earlier by analogy with the Bogolubov correlation depletion principle. 13 refs.; 5 figs.

**21536 (INIS-SU—396, pp 9-18) Analysis of e/sup +/e/sup -/ pair production in experiments with neutral kaons.** Sil'vestrov, L.V. (Joint Inst. for Nuclear Research, Dubna, USSR. Lab. of High Energy). 1986. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780089. (N—14-86).

In JINR rapid communications. Collection.

The anomalous production of e/sup +/e/sup -/ pairs which could not be explaind by the known background processes has been found as a result of the analysis of data registered on the BIS spectrometer in the experiment with neutral kaons. The invariant masses of observed pairs are limited by the M(ee)-<320-340 MeV/c/sup 2/ value. The most probable hypothesis is that the pairs could be applied to unobserved decay of K-mesons. Its relative probability is equal to (2-4)x10sup(-3). 10 refs.; 6 figs.; 2 tabs.

**21537 (INIS-SU—396, pp 19-27) Consideration of quark degrees of freedom in NN-interaction in the framework of boundary condition model (the problem of two and three nucleons).** Efimov, V.N. (Joint Inst. for Nuclear Research, Dubna, USSR. Lab. of Neutron Physics). 1986. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780089. (N—14-86).

In JINR rapid communications. Collection.

The boundary condition model (BC) of NN-interaction with energy dependent BC which has energy pole and coincides with Jaffe-Low P-matrix is considered. The internal wave function has been constructed making allowance for the quality results of quark compound bag (QCB) model. The short-range NN-potential has the structure as in QCB model but its parameters are determined via the phases of NN-scattering. The doublet length asub(2) of nd-scattering and the binding energy of tritium /sup 3/H Esub(T) for a wide interval of b (the radius BC) in the model with the external OPE-potential are calculated. For b=1.196 fm the values a/sub 2/ =0.63 fm and Esub(T)=8030 MeV are obtained that agree well with the experiment (experimental values are a/sub 2/=0.65 -+ 0.05 fm and Esub(T)=8.48 MeV). The results of this work may be considered as the first successful attempt of a joint calculation of the three-nucleon parameters a/sub 2/ and Esub(T) for the OPE-potential in the model which takes into account the quark degrees of freedom. 13 refs.; 1 tab.

**21538 (INIS-SU—396, pp 28-32) Quantization in Skyrme model with broken chiral symmetry.** Nikolaev, V.A.; Roka, E. (Joint Inst. for Nuclear Research, Dubna, USSR. Lab. of Theoretical Physics; Moskovskij Gosudarstvennyj Univ., USSR). 1986. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780089. (N—14-86).

In JINR rapid communications. Collection.

The quantization in Skyrme model with broken chiral symmetry is performed by the method of collective variables. The collective variables correspond to vibrations and rotations of skyrmions. The computed mass spectra show the energy degeneracy of some states. 6 refs.; 1 tab.

**21539 (INIS-SU—398, pp 37-42) Gluonium production in hadronic processes.** Duplij, S.A. 1985. (In Russian). NTIS (US Sales Only), PC A05/MF A01. File Number DE87780090.

In Problems of nuclear physics and cosmic rays. No. 23. Republican Interinstitute scientific technical collection.

Production of large-psub(t) scalar (O/sup ++/) and pseudoscalar (O/sup +-/) glueballs in hadronic collisions is investigated. The contribution of subprocesses q anti q -> Gg, gq->Gq, gg->Gg i s taken into account. The analysis is provided by using the helicity formalism. Helicity amplitudes and differential cross sections of glueball production for various beams and targets are obtained. It is shown that mechanisms considered lead to linear polarization of the final gluon jet, even if initial particles are unpolarized. For this case a density matrix of the final gluon is obtained. This sign of the polarization depends on th parity of the glueball and opposite for subprocesses q anti q ->Gg and gg->Gg. 6 refs.

**21540 (INIS-SU—399, pp 28-30) Confinement effect on gluon jet properties in a model of classical currents.** Nazirov, M.T. 1986. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87780091.

Kratkie Soobshcheniya po Fizike. No. 4.

In Experimental and theoretical data. Collection.

The processes of formation of gluon jets in hadron-hadron interactions are studied in the framework of the model of classical currents. Properties of gluon radiation by quarks are discussed in the model, where screening of quark color current is described by classical current acting on a finite length. Consideration of quark momentum distribution inside on incident hadron results in rather reasonable values for different characteristics of gluon (and, consequently hadron) jets with a fixed angle of escape. 3 refs.; 2 tabs.

**21541 (ITEP—77(1985)) Four-quark states in the heavy quark system.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 39p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700988.

Four-quark states Rsub(4q)=anti qanti qqq in a heavy quark system are considered in the framework of the potential model. A special attention is paid on the possibility of observing such states in a direct channel in e/sup +/e/sup -/ annihilation. It is shown that in the system anti canti ccc there must exist a resonance with Jsup(PC)=1sup(--), spin S=2, the mass M approximately 6.75 GeV, the electron width GITAsub(esup(+)esup(-)) approximately 0.02 eV and the total width GITAsub(tot) approximately 10 MeV. For analogous state in the systems anti cantiscs and anti santi sss are obtained Msub(anti canti scs) approximately 4.8 GeV, GITAsub(esup(+)esup(-)) approximately 0.4 eV and Msub(anti santi sss) approximately 2.7 GeV, GITAsub(esup(+)esup(-)) approximately 3 eV. The decay modes of such states and possibilities of their observation are discussed. The masses of C-even 4-quark states are also calculated, their 2γ decay widths and the probabilities of charmonium and upsilonium radiative decays into these states are estimated. 25 refs.; 4 figs.; 2 tabs.

**21542 (ITEP—82(1985)) P-matrix analysis of the ΛN -> ΣN system and the nature of the hadron peak near the ΣN threshold.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700989.

A P-matrix analysis of the low-energy ΛN-ΣN interactions is presented. The bag-model eigenstates in the ϵN channel are washed out by the coupling to the hadronic channels. The P-matrix analysis necessarity results in the narrow peak at the ΣN threshold. The corresponding pole may be associated with the background term of the P-matrix. This pole is classified as the inelastic virtual state of the SIGMAN system. 32 refs.

21543 **(ITEP—84(1985)) Coulomb corrections in the low-energy scattering.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 42p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700990.

Renormalization of the coefficients of the "effective range expansion" is considered for the short-range Coulomb problem. The exactly solvable model of the Coulomb plus short range potential is considered. Exact solutions are compared with approximations frequently used in the theory of hadronic atoms. 33 refs.; 7 figs.; 3 tabs.

21544 **(ITEP—128(1985)) Preasymptotical corrections to the pomeron exchange.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 21p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700992.

IN the frame of quark-gluon model for strong interactions, based on the topological expansion and string model, the planar diagrams are connected with Regge poles and the cylinder diagrams correspond to the pomeron. In earlier works it was shown that in this approach strong exchange degeneracy has to take place. This fact in the case of the pomeron with intercept αsub(D)(O)>1 is in disagreement with experiment. In the present paper the preasymptotical corrections to the pomeron exchange are calculated. It is shown that these corrections remove the dissagreement. 12 refs.; 7 figs.

21545 **(ITEP—135(1985)) Quadrupole moments of hadrons.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 18p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700993.

In chiral bag model an expression is obtained for the quark wave functions with account of color and pion interaction of quarks. The quadrupole moments of nonstrange hadrons are calculated. Quadrupole moment of nucleon isobar is found to be Q(Δ)=-6.3x10/sup -28/ esub(Δ)(cm)sup(2). Fredictions of the chiral bag model are in strong disagreement with the non-relativistic quark model. 33 refs.

21546 **(ITEP—141(1985)) On the possibility of non-weak interactions of neutrinos.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700995.

The aim of this paper is to raise a point concerning the possibility of a generalization of the standard electroweak theory which provides neutrinos with specific strong interaction and at the same time preserves the renormalizability of the theory. As an example the interaction of the neutrinos with a hypothetical neutral isosinglet scalar boson is considered. Experimental implications of the model are discussed. 14 refs.; 10 figs.

21547 **(LPC—83-01) Direct-photon pair production.** Carimalo, C.; Crozon, M.; Kessler, P.; Parisi, J. (College de France, 75 - Paris. Lab. de Physique Corpusculaire). Feb 1983. 27p. (CONF-821252—2). NTIS (US Sales Only), PC A03/MF A01. File Number DE87750986.

From Seminar on /gamma gamma/-physics; Montpellier, France (9 Dec 1982).

This paper recalls some general aspects of direct-photon pair production at large Psub(T) in hadron collisions: The basic process qantiq→γγ; contributions from gg→γγ (via the quark box); possible resonant contributions; background problems due to indirect photons. A recent experiment performed at the ISR is finally described.

21548 **Towards a resolution of certain dilemmas in preon dynamics through local supersymmetry.** Pati, J.C.; Cveti, M.; Sharatchandra, H.S. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Physical Review Letters;* **58**: No. 9, 851-854(2 Mar 1987).

A resolution of one of the major dilemmas of preon dynamics, i.e., why (m/sub q/,m/sub l/)<<(1/r₀)equivalentΛ₀, is provided. In a class of models, supersymmetry (SUSY) in its local rather than global form permits a breaking of SUSY and also a generation of composite-fermion masses, but both with a severe damping by powers of (Λ₀/M/sub Planck/).

21549 **On the existence of stable dimesons.** Heller, L.; Tjon, J.A. (Theoretical Division, Los Alamos National Laboratory, University of California, Los Alamos, New Mexico 87545). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 3, 969-974(1 Feb 1987).

The bound-state problem of two quarks and two antiquarks with coupled channels in color space is studied, using a potential as derived from the MIT bag model. For equal quark and antiquark masses no stable bound state is supported, while for large enough mass ratio a true four-quark bound state is found. The effect of a running coupling constant in the Coulomb part of the potential is studied.

21550 **Pion-nucleon bremsstrahlung and Δ electromagnetic moments.** Heller, L.; Kumano, S.; Martinez, J.C.; Moniz, E.J. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review* [*Section*] *C: Nuclear Physics;* **35**: No. 2, 718-736(Feb 1987). Contract AC02-76ER03069.

A dynamically consistent, gauge invariant model for πN bremsstrahlung is developed. The πN dynamics are described through an isobar model fit to the experimental phase shifts. The charge and current operators are constructed in a gauge invariant fashion and include contributions from interaction currents at the πNΔ vertices and from the bare Δ electromagnetic moments. The meaning of such moments for an unstable particle is discussed in detail. From a fit to the $\pi^+$p bremsstrahlung data, we extract a dipole moment for the bare Δ/sup + +/ in the range μ/sub Δ//sub =//μ/sub p/≃2.5 to 3.5; if the contributions from internal pion and nucleon currents are included, this ratio is somewhat smaller. The $\pi^-$p bremsstrahlung data are consistent with a broad range of values for μ/sub Δ//sub =/, including μ/sub Δ//sub =/ = 0. The Δ quadrupole moment cannot be extracted meaningfully from the data. We discuss the sensitivity of the extracted values of μ/sub Δ/ to the off-shell extension of the πN scattering amplitude. The polarization asymmetry is found to be sensitive to μ/sub Δ/ while being less sensitive to off-shell scattering.

21551 **Vacuum energy and dilaton tadpole for the unoriented closed bosonic string.** Grinstein, B.; Wise, M.B. (California Institute of Technology, Pasadena, California 91125). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 2, 655-659(15 Jan 1987).

In oriented-closed-bosonic-string theory a dilaton tadpole (and vacuum energy) first develops at the one-loop level from performing the path integration over manifolds with the topology of the torus. We show that in the case of the unoriented closed bosonic string the leading contribution to the dilaton tadpole arises at the tree level from the path integral over manifolds with the topology of the projective plane. We explicitly compute the vacuum energy and the dilaton tadpole using Polyakov's formulation of string theory.

21552 **Effect of transmission through the Earth on neutrino oscillations.** Baltz, A.J.; Weneser, J. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 2, 528-535(15 Jan 1987). Contract AC02-76CH00016.

Large transformation and regeneration phenomena are calculated to result from transmission through the Earth of neutrinos whose $E(MeV)/\Delta m^2(eV^2)$ lie in the vicinity of $10^6$—$10^7$. As a result large time-of-night and seasonal variations are predicted for solar neutrinos in this parameter range.

21553 **Strong-interaction contributions to one-loop leptonic processes.** Lynn, B.W.; Penso, G.; Verzegnassi, C. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 1, 42-50(1 Jan 1987). Contract AC03-76SF00515.

We classify all strong-interaction contributions to all four-lepton processes through one loop in electroweak $SU_2 \times U_1$ and to all orders in strong interactions. We show that those parts which are not reliably calculated in perturbative QCD are all related to a certain integral over the total cross section for $e^+e^- \rightarrow$hadrons at low energies. We evaluate this integral for the most recent data and find that, for most four-lepton processes of interest, it is dominated by the timelike chemical bondq'²chemical bond region from 1 to 100 GeV². We show that the associated theoretical strong-interaction uncertainty is a factor of —2 smaller than previously published estimates. We give the strong-interaction contribution and associated theoretical uncertainty for future SLAC, CERN, and Fermilab precision experiments and show that the theoretical uncertainty is quite small, thus allowing precision tests of the electroweak theory at the one-loop level.

21554 **Helicity projection techniques for evaluating cross sections of heavy-fermion production and decay via W bosons.** Barger, V.; Ohnemus, J.; Phillips, R.J.N. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 1, 166-172(1 Jan 1987).

We discuss and illustrate the application of density-matrix techniques in the helicity basis for the tree-level production and decay of heavy fermions, via real or virtual W bosons. Both Drell-Yan and O(α/sub s/) QCD production processes for W production are considered, with W→Lnu-bar/sub L/ and subsequent L and nu-bar/sub L/ decays, where L and nu-bar/sub L/ denote heavy fermions with no strong interactions (such as lepton and neutrino or W gaugino and photino). Compact expressions are given for the complete production/decay cross sections at the parton level, including possible multistage cascade decays.

21555 **Statistical analysis in new-particle searches.** Gunion, J.F.; Soper, D.E. (Physics Department, University of California, Davis, California 95616). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 1, 179-193(1 Jan 1987).

We describe methods that may be used to analyze the statistical certainty to be associated with a signal for a new particle, taking the Higgs boson as an example. We suppose that one is looking for a certain signal that the new particle is produced and decays (for example, Higgs-boson production followed by decay into $W^+W^-$ with one W→jets and one W→$\mu\nu$). We also suppose that there are calculated cross sections for the signal and for the corresponding background. We address two problems. First, how can one estimate the expected statistical significance of the result of a future experiment utilizing this signal? Second, what is a good way to analyze the data when the experiment is done? We use standard statistical methods, emphasizing a simple formulation of the problems addressed. Examples from the recent literature concerning Higgs-boson production at the Superconducting Super Collider are given.

21556 **Cross section for hard processes involving two quarks and four gluons.** Parke, S.J.; Taylor, T.R. (Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, Illinois 60510). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 1, 313-325(1 Jan 1987).

The cross section for hard processes involving two quarks and four gluons is given in a form suitable for fast numerical calculations.

21557 **Symmetric, Lorentz invariant NN amplitude: Yukawa representation.** Tjon, J.A.; Wallace, S.J. (Institute for Theoretical Physics, 3508 TA Utrecht, The Netherlands). *Physical Review* [*Section*] *C: Nuclear Physics;* **35**: No. 1, 280-297(Jan 1987).

Previous work on the general representation of NN scattering amplitudes in the full Dirac space of two nucleons is extended to allow a simple realization of the generalized Pauli principle. New kinematic covariants are found which are linearly independent and which have simple particle exchange symmetries. This permits a representation in which all invariant amplitudes are even or odd with respect to interchange of initial state four-momenta or interchange of final state four-momenta for on-mass-shell kinematics. When parity invariance, charge symmetry, and time-reversal invariance are taken into consideration, it is found that for each isospin state there are 56 independent amplitudes for off-mass-shell kinematics, 50 independent amplitudes for quasipotential kinematics, and 44 independent amplitudes for on-mass-shell kinematics. A relativistic meson exchange model is used to calculate the invariant amplitudes for on-mass-shell kinematics, and the resulting amplitudes are fit by sums of Yukawa terms. The analysis provides complete sets of Feynman invariant amplitudes for 200, 500, and 800 MeV NN scattering.

21558 **Concluding remarks and outlook.** Chau, L.L. (Brookhaven National Lab., Upton, NY). pp 761-767 of Flavor mixing in weak reactions. Chau, L.L. (ed.). New York, NY; Plenum Publishing Corporation (1985).

The author reviews recent achievements in weak interactions. Topics mentioned are the measurement of the b lifetime and other constraints on the quark mixing matrix and data on CP violation. The outlook in the near future for weak interaction physics is outlined. The author concludes with some comments on historical aspects of the construction of unified theories with special reference to supersymmetry.

21559 **Some thoughts on searches for proton decay.** Goldhaber, M. (Brookhaven National Lab., Upton, NY). pp 475-479 of Flavor mixing in weak reactions. Chau, L.L. (ed.). New York, NY; Plenum Publishing Corporation (1985).

Several general aspects of proton decay experiments are considered. It is pointed out that there is currently a gap between proton lifetime as determined by experiment and as predicted by theory. Ideal detectors, event identification and discrimination from background and reproducibility of results are discussed. Finally the author suggests the possibility of p/n asymmetry in reported events.

21560 **Estimate of $p + d \rightarrow {}^3He\ e^-e^+$ cross section at T/sub p/=450 MeV.** Prats, F.; Briscoe, W.J. pp 285-286 of Few body problems in physics. Vol.II. Zeitnitz, B. Amsterdam, Netherlands; Elsevier Science Publishers B.V. (1984).

The cross section for the pd capture into $^3$He with emission of an electron-positron pair has been estimated assuming an amplitude given by a Feynman diagram. It is found that the cross section for pair production is at least six orders of magnitude smaller than the radiative capture cross section and, therefore, can make no significant contribution to $d(p,\gamma)^3$He differential cross sections obtained in that experiment.

21561 **Speculations concerning high-energy large momentum transfer processes.** Wu, T.T.; Yang, C.N. (Brookhaven National Lab., Upton, NY). pp 365-368 of Selected papers 1945-1980 - with commentary. Chen Ning Yang. San Francisco, CA; W.H. Freeman and Company (1983).

Reprinted from Physical Review; 137: No.3B, B708-B711(8 Feb 1965).

It is speculated that the sharp decrease with increasing energy of differential cross sections at large angles is due to a mechanism independent of the method of excitation. Some consequences of such a possibility are discussed. 1 figure.

**21562 Geometrical model of hadron collisions.** Chou, T.T.; Yang, C.N. (Univ. of Georgia, Athens). pp 559-562 of Selected papers 1945-1980 - with commentary. Chen Ning Yang. San Francisco, CA; W.H. Freeman and Company (1983). Contract AS09-76ER00946.

Reprinted from Proceedings of the 1980 Guangzhou Conference on Theoretical Particle Physics; 317-326(1980).

Results obtained from the geometrical model for high energy hadron-hadron and hadron-nucleus collisions are summarized. The discussion is focused on elastic scattering, diffraction dissociation process and the concept of matter current distribution inside a polarized hadron or nucleus.

## 6453 Particle Invariance Principles And Symmetries

*REFER ALSO TO CITATION(S) 21548, 21594, 21604*

**21563 (DOE/ER/40200—088) Quasi-invariance and central extensions.** Marmo, G.; Morandi, G.; Simoni, A.; Sudarshan, E.C.G. (Texas Univ., Austin (USA). Center for Particle Theory). Feb 1987. Contract FG05-85ER40200. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006234.

The free particle with equations of motion invariant under the ten-parameter Galilei group, but with its Lagrangian only quasi-invariant, changing by a total time derivative, is discussed. An example is considered where the Lagrangian is quasi-invariant, and it is shown how that gives rise to a central extension of the Euclidean group E(2). The corresponding problem is then considered on phase space where a problem arises because the kinematics and the dynamics, both carried by the Lagrangian function, now are separately associated with the Poisson Brackets and the Hamiltonian function. The rise of central extensions are shown here too. An example is exhibited where central extensions are trivial and therefore strictly invariant Lagrangians can be defined. (LEW)

**21564 (EFI—815(42)-85) Quantum geometry of covariant superstring with N=1 global supersymmetry.** (Erevanskij Fizicheskij Inst. (USSR)). 1985. 10p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700863.

Quantization of superstring with N=1 global supersymmetry in continual integration formalism is considered. It is shown that integral over anticommuting variables is determined by conformal anomaly of induced metric. The total effective action is a combination of a string action and that of Liouville model. 12 refs.

**21565 (EFI—817(44)-85) Supersymmetry and intermediate symmetry breaking in SO(10) superunification.** (Erevanskij Fizicheskij Inst. (USSR)). 1985. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701364.

A scheme of simultaneous breakdown of intermediate symmetry SO(10) -> SU(3)sub(c) x U(1) x SU(2)sub(L) x SU(2)sub(R) and supersymmetry by means of a single scale parameter is suggested. This intermediate symmetry, which is preferable physically, owing to the broken supersymmetry has a minimum lying lower than SU(4) x SU(2)sub(L) x SU(2)sub(R). The intermediate symmetry is broken by the vacuum expectation value of the Higgs superfields. Owing to the quantum corrections the potential minimum turns out to correspond to breakdown of the intermediate symmetry up to the standard group SU(3)sub(c) x SU(2)sub(L) x U(1)sub(y). The value of the Weinberg angle is less than that in the supersymmetric SU(5) model and agrees with the experiment. 13 refs.; 2 figs.

**21566 (IC—86/4) Symmetries and a hierarchy of the general modified KdV equation.** (International Centre for Theoretical Physics, Trieste (Italy)). Jan 1986. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701369.

Two groups of symmetries and their Lie algebra property of the modified KdV equation are extended to the general modified KdV equation and the Miura transformation between the general KdV equation and the general modified KdV equation is also established. 8 refs.

**21567 (IC—86/6) Stable harmonic maps from complete manifolds.** (International Centre for Theoretical Physics, Trieste (Italy)). Jan 1986. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701374.

By choosing distinguished cross-sections in the second variational formula for harmonic maps from manifolds with not too fast volume growth into certain submanifolds in the Euclidean space some Liouville type theorems have been proved in this article. 9 refs.

**21568 (IC—86/56) Light gluinos and CP violation.** (International Centre for Theoretical Physics, Trieste (Italy)). Apr 1986. 11p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701370.

It is shown that SUSY models with light gluinos, in contrast to the heavy gluino scenario, have the right amount of flavour mixing in the down squark mass matrix to explain naturally the observed $\epsilon$ parameter even for low top mass (m/sub t/ approx = 40 GeV) and long bottom life (tau/sub B/> or approx 1 ps). Implications for $\epsilon'/\epsilon$ and B/sup o/-B/sup -o/ mixing are discussed. 27 refs, 1 tab.

**21569 (IC—86/57) Renormalizable N=2 supersymmetric and gauge invariant interactions from the N=2 harmonic superspace with central charges.** (International Centre for Theoretical Physics, Trieste (Italy)). Apr 1986. 27p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87701371.

The N=2 harmonic-superspace in the presence of central charges is developed. Renormalizable interactions unusual in N=2 supersymmetric theories, are derived in a consistent way. Symmetries generated by the central charges are discussed. A certain equivalence between N=2 harmonic superspace with and without central charges is established. A non-abelian generalization of the model is given. 26 refs.

**21570 (IC—86/58) On the renormalizable interactions of the N=2 Maxwell and scalar multiplets in the N=2 harmonic superspace.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701372.

We work out the renormalizable local U(1) and global SU(2) invariant interactions in the N=2 harmonic superspace. A convenient invariant gauge choice is introduced. 15 refs.

**21571 (IC—86/59) N=2 SQED in the N=2 harmonic-superspace.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 23p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701373.

We study in the Harmonic Superspace an N=2 supersymmetric U(1) gauged model based on the interaction of a massive Fayet-Sohnius hypermultiplet and a gauge multiplet. This model has an extra symmetry which, when gauged away, reproduces the N=2 SQED. The Fayet-Iliopoulos mechanism is used to break the N=2 supersymmetry down to N=0 in a covariant way. Other features are discussed. 15 refs.

**21572 (IC—86/60) Spontaneous N=2 supersymmetry breaking in the N=2 harmonic superspace a la Fayet-Iliopoulos.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701375.

The spontaneous N=2 supersymmetry breaking in a hyper PHI/sup 3/ model is studied. Some special features such as the possibility of an inverse Higgs mechanism are analysed in a covariant framework. 18 refs, 4 figs.

**21573 (IC—86/63) Constraints on the squark mass matrix from CP-violation and SUSY predictions for the B/sup o/ - B/sup o/-bar systems.** (International Centre for Theoretical Physics, Trieste (Italy)). Apr 1986. 21p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701376.

The parameters c and A of the squark mass matrix, which control flavour violation and left-right mixing respectively, are constrained by fitting $\epsilon$ and $\epsilon'$. The predictions for mixing and CP-vio-

lation in the B/sup o/ - B/sup o/-bar system are calculated and then compared with both the predictions of the standard model and the available experimental data. 40 refs, 2 figs, 2 tabs.

21574 **(IC—86/65) Behaviour of coupling constants at high temperature in supersymmetric theories.** (International Centre for Theoretical Physics, Trieste (Italy)). Apr 1986. 11p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701377.

An analysis is presented of the temperature dependence of the coupling constants using the improved one-loop approximation in the Wess-Zumino model and the supersymmetric O(N) model. It is found that all the coupling constants, both bosonic (PHI/sup 4/ type) and Yukawa, approach constant nonzero values as T->∞. The asymptotic values of the bosonic couplings are slightly smaller than the corresponding zero-temperature values, and those of the Yukawa couplings are the same as the zero-temperature values. 10 refs, 1 fig.

21575 **(IC—86/73) (4,O) heterotic string with Wess-Zumino term.** (International Centre for Theoretical Physics, Trieste (Italy)). May 1986. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701378.

The covariant SU(2) spinning string model of Pernici and van Nieuwenhuizen which has (4,4) supersymmetry is chirally truncated to a (4,0) model. The model is extended by the addition of a locally supersymmetric Wess-Zumino term, and heterotic fermions. This system is coupled to composite as well as fundamental Yang-Mills gauge fields. 19 refs.

21576 **(IC—86/81) On the functional Lie-Baecklund symmetries for one-dimensional gas dynamics.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701379.

We have analysed the equations of one-dimensional gas dynamics from the point of view of the Lie-Baecklund transformation. The important outcome of our analysis is that these extended symmetry transformations can have arbitrary functional form in terms of jet variables. Both the cases of coupled and decoupled sets of equations have been considered. 3 refs.

21577 **(IC—86/94) Extended Poincare supersymmetry.** (International Centre for Theoretical Physics, Trieste (Italy)). May 1986. 40p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87701380.

Supersymmetric extensions of the Poincare algebra in D-dimensional space-time are reviewed and a catalogue of their representations is developed. This catalogue includes all supermultiplets whose states carry helicity <2 in the massless cases and <=1 in the massive cases. 3 refs, 6 tabs.

21578 **(IC—86/115) Global anomalies in six dimensions.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701365.

Applying Witten's formula for global gauge and gravitational anomalies to six dimensional supergravities, we find: (a) The perturbatively anomaly free N=4 chiral supergravity coupled to 21 tensor multiplets is global anomaly free for any choice of spacetime manifold with vanishing third Betti number (b/sub 3/). (b) The perturbatively anomaly free matter coupled N=2 chiral supergravities with arbitrary number of tensor multiplets, whose Yang-Mills gauge groups do not include G/sub 2/, SU(2), or SU(3) are free of global anomalies if the theory is formulated on S/sup 6/. In the case of 9 tensor multiplets coupled to supergravity this result holds for any spacetime with vanishing b/sub 3/. (c) The N=6 chiral supergravity has perturbative gravitational anomalies, and therefore the global anomalies need not be considered in this case. 26 refs.

21579 **(IC—86/123) Characters of the irreducible highest weight modules over the Virasoro and super-Virasoro algebras.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 19p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701366.

The characters of all irreducible highest weight modules over the Virasoro algebra and the N=1 super-Virasoro algebras (i.e. Neveu-Schwarz and Ramond superalgebras) are given in an explicit and unified for all algebras form incorporating all previously known results. Extensions to the N=2 super-Virasoro case and to the super-Kac-Moody algebra osp(2,2)/sup (1)/ are discussed. 38 refs.

21580 **(IC—86/133) Extension of SU(m) algebra to graded superalgebra.** (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1986. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701367.

We consider a method of extending the SU(m) algebra to graded superalgebra based on the use of equal-time canonical commutation relations for matter field operators. 12 refs.

21581 **(IC—86/138) Baryon and lepton number violation in superstring motivated models.** (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1986. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701368.

We discuss how realistic low energy physics can arise from the E/sub 8/xE/sub 8/ superstring. A key role is played by the discrete symmetries which typically arise after compactification. Cosmological problems are avoided because the discrete symmetry we employ is shown to effectively be embedded in a Peccei-Quinn symmetry. The models we present seem to satisfy the known phenomenological constraints. In particular, they possess a harmless axion. Implications for baryon and lepton number violation are discussed. 12 refs, 2 figs, 2 tabs.

21582 **Supersymmetric compactification of the heterotic string on coset spaces.** Govindarajan, T.R.; Joshipura, A.S.; Rindani, S.D.; Sarkar, U. (Loyola College, Madras 600 034, India). *Physical Review Letters;* **57**: No. 20, 2489-2492(17 Nov 1986).

Compactification of ten-dimensional $E_8 \times E_8$/sup '/ heterotic string theory on coset manifolds is discussed. It is pointed out that N = 1 supersymmetry can be preserved on $G_2/SU(3)$, SO(5)/SU(2)xU(1), and SU(3)/U(1)xU(1) if gauge-fermion condensation occurs and the third-rank antisymmetric field strength is nonzero. In particular, three generations of chiral fermions can be obtained.

21583 **Epilogue.** Goldhaber, M. (Brookhaven National Lab., Upton, NY). pp 287-290 of Symmetries in particle physics. Bars, I.; Chodos, A.; Tze, C.H. New York, NY; Plenum Publishing Corporation (1984).

The authors have come here tonight for a very happy occasion: to celebrate Feza Guersey's 60th birthday. Yoichiro Nambu told us this morning that someone started this universe by pulling strings. They all agree that this was a good beginning considering that it finally led to Feza. Freeman Dyson in the last talk today told us that there is a long time gap before the work of a man of such depth as Feza is appreciated; clearly they shall have to come back here for his 120th birthday. When Feza makes a grant application to one of the agencies he could say in his modest way: this may show its value in fifty or a hundred years. Feza has been honored many times before, but to be honored right at home is a very special honor indeed, and I hope he will remember that. They all enjoy Feza's success, especially because it disproves Leo Durocher's famous conjecture that nice guys finish last.

21584 **Isotopic spin conservation and a generalized gauge invariance.** Yang, C.N.; Mills, R. (Brookhaven National Lab., Upton, NY). pp 171 of Selected papers 1945-1980 - with commentary. Chen Ning Yang. San Francisco, CA; W.H. Freeman and Company (1983).

Reprinted from Physical Review; 95: 631(1954).

The concept of gauge invariance has been generalized to apply isotopic spin conservation. It turns out that a very natural generalization is possible. The field that plays the role of the electromagnetic field is here a vector field that satisfies a nonlinear equation even in the absence of other fields. (This is because unlike the electromagnetic field this field has an isotopic spin and consequently acts as a source of itself.) The existence of a current density

is automatic, and the interaction of this field with any fields of arbitrary isotopic spin is of definite form (except for possible terms similar to the anomalous magnetic moment interaction terms in electrodynamics).

## 6454 Field Theory

*REFER ALSO TO CITATION(S) 21574, 21582, 21834, 22061*

21585 **(IC—86/8) Super integrable systems and its infinite conserved currents.** (International Centre for Theoretical Physics, Trieste (Italy)). Jan 1986. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701358.

The 3 x 3 super extended eigenvalue problem is considered. We deduce a class of completely integrable equations. Its reduced forms are given and their infinite conserved currents have been discussed. 7 refs.

21586 **(IC—86/9) Harmonic mapping actions and nonlinear $\sigma$-model.** (International Centre for Theoretical Physics, Trieste (Italy)). Jan 1986. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701360.

Fibre bundle formulations of field theory are considered approximately by the appropriate vector bundle. The fibre vierbein (frame) is considered as dependent indirectly on an element f of the fibre group, which we choose as a harmonic mapping from the base manifold. We do the same for the other fundamental geometrical quantity called the connection, but choose another independent harmonic mapping h instead of f. Additionally, we generalize the torsion-free condition to this more general vector bundle other than tangent bundle, by using the pullback mapping. A new gauge invariant Lagrangian is proposed. 7 refs.

21587 **(IC—86/46) Corrections to the Goldberger-Treiman relation and the QCD condensates.** (International Centre for Theoretical Physics, Trieste (Italy)). Apr 1986. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701357.

The Goldberger-Treiman discrepancy is related to the values of the QCD vacuum condensates. The range of the latter consistent with the experimental value of the former is given. 9 refs, 5 figs.

21588 **(IC—86/83) Spontaneous breaking of global and local symmetries in six-dimensional Einstein-Maxwell-$\sigma$ theory.** (International Centre for Theoretical Physics, Trieste (Italy)). May 1986. 17p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701359.

Higher winding number solutions of the non-linear $\sigma$ field are used to break the global as well as local symmetry of SU(2) in a six-dimensional gravity theory coupled with the U(1) Maxwell and $\sigma$-field. The masses of three gauge bosons are split and their ratios of masses are obtained for various winding numbers. The low-lying states of this model not of Planck scale are a scalar triplet, the graviton, photon, and low mass gauge bosons. 11 refs, 1 tab.

21589 **(IC—86/106) Compactifications and $\theta$-structures in string theories.** (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1986. 11p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701354.

Possible topological invariant terms in the first quantization of strings associated with nonzero elements of the second cohomology group of space-time are investigated. The direct result of such terms is C-violation. 12 refs.

21590 **(IC—86/124) Covariant field theory of the interacting string.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 23p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701355.

A covariant field theory for the interacting string recently proposed by a Kyoto group is discussed. 15 refs, 5 figs.

21591 **(IC—86/126) Vacuum stability in Kaluza-Klein theories.** (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1986. 10p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701356.

When it was discovered that string theories are inconsistent except when they are formulated in spacetimes of either 26 or 10 dimensions, a new reason for investigating dynamical geometry was born. Up to this point the general theory of relativity had stood in isolation. The gravitational force, based as it was in the geometry of spacetime, seemed different from the other "fundamental" forces. It is true that, among the proposals for unification, there was an early suggestion by Kaluza that spacetime should be viewed as a 5-dimensional cylinder in order to put electromagnetism on the same geometrical footing as gravitation. Interesting as it was, this idea was somewhat premature in that many fundamental forces had yet to be discovered. This may yet be the case. If electromagnetism is to be explained by such a mechanism then the distance scales (e.g. the cylinder's radius) must be smaller by many orders than what is experimentally resolvable. This means that the most novel and distinctive qualities of the 5-dimensional geometry, the most characteristic predictions of the theory, cannot be tested. For this reason, the Kaluza-Klein theories have remained for many years a curiosity, and Einstein's theory of gravitation maintains its isolation. 16 refs.

21592 (INIS-SU—398, pp 68-72) **Scale transformations of the affine connection.** Mola, R. 1985. (In Russian). NTIS (US Sales Only), PC A05/MF A01. File Number DE87780090.

In Problems of nuclear physics and cosmic rays. No. 23. Republican Interinstitute scientific technical collection.

Three most wide-spread types of group variety geometry are shown to be obtained as particular cases of the geometry family. Geometries differ from each other by a scale transformation of structure constants and by corresponding re-determination of the multiplication law in the Zee algebra of the Zee group with a constant scale multiplier. Structure equations for all scale-equivalent geometries are obtained. These equations are invariant to general linear transformations of a Zee algebra element, localized in group variety, if in this case the affine connection possesses a gauge transformation law. 7 refs.

21593 **(ITEF—35(1985)) Infrared and collinear divergences in field theory.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 51p. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87700968.

Solution of the problem, related to infrared divergences in quantum electrodynamics (QED), is described in detail. Collinear divergences, leading in a number of cases to the twofold logarithmic amplitude asymptotics, are discussed. Kinoshita-Lee-Nanenberg theorem is formulated. A brief review of situation in quantum chromodynamics (QCD) is made. Kinematic graph structure in QCD is in general similar to that in QED, but there are some significant particular differences, among which the most important one is the violation of soft quantum free emission. "Infrared" ideology allows to describe uniformly such different QCD phenomena as jet formation cross section, scaling violation in deep inelastic scattering Drell-Jahn process at high transverse momenta of a lepton pair and exclusive processes at large momentum transfers. 22 refs.; 23 refs.

21594 **(ITEP—39(1985)) Supersymmetry in a space with auxilliary dimensions.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 52p. NTIS (US Sales Only), PC A04/MF A01. File Number DE87700985.

The purpose of the paper is to clarify geometrical constructions which lead to unconstrained superfields in extended supersymmetry. A geometrical interpretation of constraints in N=2 super Yang-Mills superfield theory is given. Auxiliary variables are introduced. The basic superspace with auxiliary variables, in particular, the isotwistor space, relevant to the N=2 case are described. A reformulation of N=2 super Yang-Mills constrains is constructed in terms of superfields on isotwistor space. 13 refs.

21595 **(ITEP—75(1985)) Beta function in supersymmetric gauge theories. Instantons versus traditional approach.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700987.

Within the background field formalism vacuum loops in supersymmetric gauge theories are discussed. A direct connection is revealed between the absence (or presence) of high order contributions and infrared regularization. A simple explanation is given why the instanton amplitude is exhausted by one loop whilst in the standard supergraph technique the effective action contains terms of all orders in the coupling constant. Exact relation between the Gell-Mann-Low function and anomalous dimensions of matter superfields stemming from the instanton calculus are presented. 7 refs.; 1 fig.

21596 **(ITEP—94(1985)) Quasiperiodical orbits in the scalar classical lambdaphi/sup 4/ field theory.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 25p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700991.

New numerical and theoretical results of resonance kink-antikink (Kanti K) interactions in the classical one-dimentional space Higgs theory are presented. Earlier studies of these interactions revealed nine initial relative velocity-intervals with two-bounce Kanti K-collisions followed by the escape of kinks to infinite separations, the breathing solution was formed outside those intervals. Two-bounce Kanti K-interactions with the number of small oscillations between Kanti K-bounces up to 35 in the initial kink velocity interval 0.18 <= Vsub(infinite) <= 0.26 were found. Several examples for n-bounces Kanti K-interaction (n <= 6) are also found. The observed phenomenon can be explaned by the existence of quasi-two-periodical solutions of the nonlinear wave equation. The simple Hamiltonian with two degrees of freedom is studied. This model supplies quantitative descrtiptions of all numerical results for the field theory considered above. The considered phenomenon may be called "autoquantization" of a nonlinear classical scalar selfinteracting field. 19 refs.; 5 figs.; 2 tabs.

21597 **(ITEP—137(1985)) SUSY non-Abelian gauge models: exact beta function from one loop of perturbation theory.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 18p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700994.

The method for calculating the exact $\beta$ function (to all orders in the coupling constant) proposed earlier in supersymmetric electrodynamics is extended. The starting point is the observation that the low-energy effective action is exhausted by one loop provided that the theory is regularized supersymmetrically both in the ultraviolet and infrared domains in four dimensions. The Pouli-Villars method of the ultraviolet regularization is used. Two methods for the infrared regularization are considered. The first one - quantization in a box with a finite volume L/sup 3/ - is universally applicable to anygauge theory. The second method is based on the effective Higgs mechanism for mass generation and requires the presence of certain matter superfields in the Lagrangian. Within this method the necessary condition is the existence of flat directions, so called valleys, along which the vacuum energy vanishes. The theory is quantized near epsilon non-vanishing value of the scalar field from the bottom of the valley. After calculating the one-loop effective action one and the same exact expression is obtained for the $\beta$ function within the both approaches, and it also coincides with our earlier result extracted from instanton calculus. A few remarks on the problem of anomalies in SUSY gauge theories are presented. 14 refs.

21598 **(ITEP—146(1985)) Operator product expansion and calculation of the two-loop Gell-Mann-Low function.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700996.

A simple method for determining the Gell-Mann-Low function is developed. The method allows one to determine the k-loop coefficient of $\beta$-function in gauge theories provided the operator expansion is constructed in (k-1) loop for certain two-point functions. The calculation of the two-loop coefficient of the Gell-Mann-Low function becomes trivial - it reduces to a few algebraic operations with expressions which are already known. Spinor, scalar and supersymmetric electrodynamics are considered. Although the corresponding results for $\beta$ are known in the literature, both the method of the calculations and some points referring to the construction of the operator expansion are novel. 8 refs.; 3 figs.; 1 tab.

21599 **(ITF—86-23-R) Phase transitions in QCD-thermodynamics on a lattice.** Gorenshtejn, M.I. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1986. 17p. (In Russian). (CONF-8510419—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700997.

From 1. All-Union conference computer experiment in quantum field theory; Alma-Ata, USSR (1 Oct 1985).

The problem on temperature phase transitions in lattice gauge theories is briefly reviewed. The most part of the review concerns the gluon QCD sector (i.e. theory consideration without quarks). This restriction is justified as it becomes clear lately that though quark inclusion leads to serious technological difficulties it doesn't change qualitatively the picture of phase transition of deconfinement obtained in the lattice thermodynamics of Yang-Mills fields. 24 refs.; 6 figs.

21600 **(JINR—E-2-86-17) Finite N=1 supersymmetric grand unified theories.** (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1986. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701361.

Submitted to the journal Nucl. Phys., B.

An algorithm to construct N=1 supersymmetric Yang-Mills theories finite in all orders of perturbation theory is proposed. Necessary and sufficient conditions for finiteness are determined already in the one-loop approximation. The class of such theories is wide enough and not exhausted by N=4 or N=2 supersymmetric models. Several examples of finite theories are considered. Finite realistic N=1 supersymmetric grand unified theory is proposed which is based on SU(5) gauge group and contains three fermion families with necessary Higgs multiplets. 18 refs.

21601 **(JINR—R-2-86-16) Auxiliary spectral problem in fermionic string theories.** (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1986. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701362.

The auxiliary spectral problem arising in the fermionic string model is investigated in order to study the fermionic string dynamics in noncompact Lie groups. A complete set of the "action" type variables is obtained and fermionic string reduction to supersymmetry systems with finite-number degrees of freedom is discussed. These results reveal the possibility to construct a correct quantum theory of the fermionic astrings in the space-time of arbitrary dimension. 6 refs.

21602 **(KFKI—1986-29/A) New hypothesis on the nature of quark and gluon confinement.** (Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics). Jun 1986. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701363.

A new hypothesis of quark confinement is proposed: formation of superbound states in light quark vacuum analogical to the electron states in the field of nuclei about Z 180. The vacuum polarization effect of a heavy antiquark produces a light quark-antiquark pair. If the effective charge of the central particle is greater than a critical value, the new antiquark goes to the infinity and the bounded quark screenes the color field of the central charge. Thus, the colored states are unstable and vacuum polarization produces colorless bound states. A similar effect of gluon instability can explain the structure of mesons with light quarks and antiquarks: the central self-bounded unstable gluon state polarizes and binds a light quark-antiquark pair. Consequences of the new hypothesis on the measurability of color charge, on the structure of baryons and on

the possible experimental verification of the existence of the proposed structures are discussed. (D.Gy.). 4 refs.; 5 figs.

21603 **Scalar Casimir energies in M⁴≧/sup N/ for even** N. Kantowski, R.; Milton, K.A. (Department of Physics and Astronomy, The University of Oklahoma, Norman, Oklahoma 73019). *Physical Review [Section] D: Particles and Fields;* **35**: No. 2, 549-556(15 Jan 1987).

We construct a Green's-function formalism for computing vacuum-fluctuation energies of scalar fields in 4+N dimensions, where the extra N dimensions are compactified into a hypersphere S/sup N/ of radius a. In all cases a leading cosmological energy term u/sub cosmo/proportionala/sup N//b/sup 4+N/ results. Here b is an ultraviolet cutoff at the Planck scale. In all cases an unambiguous Casimir energy is computed. For odd N these energies agree with those calculated by Candelas and Weinberg. For even N, the Casimir energy is logarithmically divergent: u/sub Casimir/—(α/sub N//a⁴)ln(a/b). The coefficients α/sub N/ are computed in terms of Bernoulli numbers.

21604 **On toroidal compactification of heterotic superstrings.** Ginsparg, P. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). *Physical Review [Section] D: Particles and Fields;* **35**: No. 2, 648-654(15 Jan 1987).

I comment on the use of background gauge fields and antisymmetric tensor fields in toroidal compactification of heterotic strings, and explicitly construct the background gauge field that interpolates between the $E_8 \times E_8$ and $Spin(32)/Z_2$ theories defined on $R^9 \times S^1$.

21605 **Topologically massive chromodynamics at finite temperature.** Pisarski, R.D. (Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, Illinois 60510). *Physical Review [Section] D: Particles and Fields;* **35**: No. 2, 664-671(15 Jan 1987).

Topologically massive chromodynamics is studied at a finite temperature T. The topological gauge invariance present at T = 0 is argued to remain valid at Tnot =0, but verifying this in the quantum theory is far less direct at Tnot =0 than at T = 0. Debye screening occurs, and has a striking effect on the correlations of static magnetic fields. The behavior of the free energy at high temperature is also computed.

21606 **Effective gauge action on a finite-size lattice.** Bitar, K.M. (Supercomputer Computations Research Institute, Florida State University, Tallahassee, Florida 32306). *Physical Review [Section] D: Particles and Fields;* **35**: No. 2, 691-695(15 Jan 1987).

We present evidence to support the idea that finite-size effects for Monte Carlo simulations of gauge theories on a lattice may be represented by an effective action which could be measured for the particular lattice at hand. For SU(2) lattice-gauge-theory simulations this implies a shift in the coefficients (inverse coupling parameters) of the character expansion of the action being simulated. This shift can be measured and is observed to occur as expected in the crossover region and beyond into the weak-coupling domain.

21607 **Thermodynamic properties of the gluon plasma.** DeGrand, T.A.; DeTar, C.E. (Physics Department, University of Colorado, Boulder, Colorado). *Physical Review [Section] D: Particles and Fields;* **35**: No. 2, 742-747(15 Jan 1987).

We calculate the energy density, pressure, and speed of sound in the deconfined phase of lattice SU(3) gauge theory at finite temperature for lattices of temporal size N/sub t/ = 4, 6, and 8. We compare our results with perturbative QCD at high temperature and with a simple phenomenological model. We also parametrize our results using the "bag" equation of state.

21608 **Gauge theories at finite temperature and chemical potential.** Elze, H.; Miller, D.E.; Redlich, K. (Nuclear Science Division 70A, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Physical Review [Section] D: Particles and Fields;* **35**: No. 2, 748-752(15 Jan 1987).

The relativistic partition function is studied respecting the internal symmetries. We consider generally the SU(N) gauge theories, and, in particular, the SU(3) symmetry relating to the quark-gluon plasma. The implications of the complex chemical potentials are analyzed and discussed in relation to the lattice gauge theories. It is explicitly shown that the physical partition function is real, which can be obtained from a complex Euclidean partition function by imposing Gauss's law.

21609 **Heat-kernel regularization of gauge theory.** Bern, Z.; Halpern, M.B.; Kalivas, N.G. (Lawrence Berkeley Laboratory and Department of Physics, University of California, Berkeley, California 94720). *Physical Review [Section] D: Particles and Fields;* **35**: No. 2, 753-756(15 Jan 1987). Contract AC03-76SF00098.

We discuss the heat-kernel option in the new covariant-derivative regularization program. The exponential regularization is generally simpler and more systematic than the previously studied power-law regulators. As a result, for example, we are able to verify the vanishing gluon mass in all dimensions at once.

21610 (JINR—D-17-84-850-Vol.2, pp 53-72) **Soliton excitations in a class of nonlinear field theory models.** Makhan'kov, V.G.; Fedyanin, V.K. 1985. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE87780102. (CONF-8408213—Vol.2).

From 3. international symposium on selected topics in statistical mechanics; Dubna, USSR (22 Aug 1984).

Investigation results of nonlinear models of the field theory with a lagrangian are described. The theory includes models both with zero stable vacuum epsilon=1 and with condensate epsilon=-1 (of disturbed symmetry). Conditions of existence of particle-like solutions (PLS), stability of these solutions are investigated. Soliton dynamics is studied. PLS formfactors are calculated. Statistical mechanics of solitons is built and their dynamic structure factors are calculated.

21611 (JINR—D-17-84-850-Vol.2, pp 94-105) **Many-body content of quantum gauge theories and its connection to mass generation mechanisms.** Natoli, C.R.; Palumbo, F. (Istituto Nazionale di Fisica Nucleare, Frascati, Italy. Lab. Nazionale di Frascati). 1985. NTIS (US Sales Only), PC A16/MF A01. File Number DE87780102. (CONF-8408213—Vol.2).

From 3. international symposium on selected topics in statistical mechanics; Dubna, USSR (22 Aug 1984).

The aim of the paper is to get more knowledge about many-body systems and their properties, about many-body content of quantum gauge theories and its connection with mass generation mechanisms. The way to achieve this is to perform the galilean limit of the relativistic theory by sending the speed of light c to infinity. This limiting process exposes the low energy behaviour of the relativistic theory.

21612 (JINR—D-17-84-850-Vol.2, pp 276-280) **Phase transition in the 1+1 dimensional phi/sup 4/ model with fermions.** Fedyanin, V.K.; Osipov, V.A. 1985. NTIS (US Sales Only), PC A16/MF A01. File Number DE87780102. (CONF-8408213—Vol.2).

From 3. international symposium on selected topics in statistical mechanics; Dubna, USSR (22 Aug 1984).

The phase transition with the symmetry restoration in the two-dimensional phi 4-model is studied when the fermions are included. The model is used both in relativistic field theory and in condensed matter physics. The effects due to the fermion-density increase are considered. Calculations are carried out only in the lowest order of perturbation theory.

21613 **Workshop on non-perturbative quantum chromodynamics.** Milton, K.A.; Samuel, M.A. (eds.). Cambridge, MA; Birkhaeuser (1985). 265p.

From review by Geoffrey B. West, Los Alamos National Lab. in Foundations of Physics, Vol. 15, No. 2 (Feb 1985).

The book is a collection of papers presented at a three-day Workshop on Non-Perturbative QCD held in the spring of 1983 at

Oklahoma State University in Stillwater and organized by Kimball Milton and Mark Samuel. Many topics relevant to this subject are covered, though there are some important and potentially serious omissions. These include Borel summability and renormalons (i.e., perturbation theory as an asymptotic series) and the role of the topological structure of the theory (though there is a paper discussing its signature in lattice gauge theory). For those interested in finding out what the current state of some attempts to deal with QCD nonperturbative are, this book is a valuable source. Most of the papers are well written and clear, though addressed to a reasonably knowledgeable expert.

# 65 PHYSICS II

*REFER ALSO TO CITATION(S) 21290*

21614 **(CENBG—8329) Annual report 1981-1982.** (Bordeaux-1 Univ., 33 - Gradignan (France). Centre d'Etudes Nucleaires). 1983. 119p. (In French). NTIS (US Sales Only), PC A06/MF A01. File Number DE87751054.

The activities of the nuclear research center of Bordeaux-Gradignan are reported here. The important subjects are nuclear spectroscopy, fission (fragmentation and dynamics), nuclear interaction mechanisms (high energy, neutron-induced reactions, heavy-ion induced reactions), X spectroscopy.

21615 **(INIS-mf—10565) Experimental and theroetical physics. Collection.** (AN SSSR, Moscow. Fizicheskij Inst.). 1985. 69p. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780085.

Kratkie Soobshcheniya po Fizike. No. 3.
Individual papers in this collection are abstracted separately.

21616 **(INIS-SU—380) Experimental and theoretical physics. Collection.** (AN SSSR, Moscow. Fizicheskij Inst.). 1985. 65p. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780086.

Kratkie Soobshcheniya po Fizike. No. 5.
Individual papers have been cataloged separately.

## 6510 Nuclear Physics

*REFER ALSO TO CITATION(S) 21296, 21489, 21490, 21491, 21501, 21503, 21504*

21617 **(BNL-NCS—39162) On-line access to ENSDF [Evaluated Nuclear Structure Data File].** Pearlstein, S. (ed.). (Brookhaven National Lab., Upton, NY (USA)). Jun 1986. Contract AC02-76CH00016. 13p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87006460.

The main purpose of this study is to develop a unified plan to provide users with on-line access to numeric nuclear structure data and provide, in a people readable format, information not published in Nuclear Data Sheets.

21618 **(CEA-CONF—8544) Photonuclear and electronuclear Saclay's activities.** Schuhl, C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Aug 1986. 10p. (CONF-860866—1; CEA-DPH-N-S—2373). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751039.

From Gordon research conference on photonuclear reactions; Plymouth, NH, USA (4 Aug 1986).

Research is carried at the 700 MeV linear electron accelerator of Saclay (ALS). Among the results obtained these years, we note the most significant ones: the study of the reaction $^3$He($\gamma$,p)np, i.e. the photodisintegration of helium-3 without pion emission, has been developed. At the same time, a method for measuring the reaction $^3$He($\gamma$,pp)n, in which two protons are detected in coincidence, has been improved. The comparison of electron-nucleus and positron-nucleus scattering has just been undertaken. The completion of the detection systems placed in the focal planes of the two high resolution magnetic spectrometers has given an emphasis to the studies of reactions of the type (e,e'p), where the scattered electron and the proton ejected from the nucleus are detected in coincidence.

21619 **(CEA-N—2483) Subthreshold pion production of 20-100 MeV energy with various projectiles (p, $^3$He, $^{12}$C, $^{16}$O).** Sanouillet, G.; Bolore, M.; Charlot, X. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). May 1986. 290p. (In French). NTIS (US Sales Only), PC A13/MF A01. File Number DE87751061.

The described experiments refer to pion production below and near the threshold with different projectiles (p, $^3$He, $^{12}$C, $^{16}$O). The pion detection device was a range telescope. Experimental methods are presented and discussed. Data are compared to predictions of some models.

21620 **(DOE/ER—0311) Summaries of FY 1986 research in nuclear physics.** (USDOE Office of Energy Research, Washington, DC. Nuclear Physics Div.). Mar 1987. 193p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE87006593.

This report summarizes the research projects supported by the Division of Nuclear Physics in the Office of High Energy and Nuclear Physics, during FY 1986. This Division is a component of the Office of Energy Research, the basic research branch of the US Department of Energy, and provides about 80% of the funding for nuclear physics research in the United States. The objective of the Nuclear Physics program is to understand the interactions, properties, and structures of nuclei and nuclear matter and to understand the fundamental forces of nature as manifested in atomic nuclei. These summaries are intended to provide a convenient guide for those interested in the research supported by the Division of Nuclear Physics.

21621 (INIS-SU—386, pp 18-28) **Study of high energy gamma-rays in heavy ion reactions.** Kamanin, V.V.; Kugler, A.; Mikhajlova, T.I.; Penionzhkevich, Yu.E.; Sobolev, Yu.G.; Yeremin, N.V. 1985. NTIS (US Sales Only), PC A04/MF A01. File Number DE87780087. (N—8-85).

In JINR rapid communications. Collection.

The gamma-spectra up to gamma-ray energy of 20 MeV in coincidence with KX-rays and fission fragments were measured. The reactions induced by /sup 15/N, /sup 22/Ne, /sup 40/Ar ions with E/A=5.5-10 MeV/nucleon leading to the formation of the Yb or Bi compound nuclei were studied. The /sup 130/Te, /sup 150/Te, /sup 150/Nd, /sup 153/Eu, /sup 159/Tb, /sup 181/Ta, and /sup 192/Os targets were used. The gamma-rays were registered by a NaJ(Tl) scintillation detector with phi 150 x 100 mm dimensions. The effective temperature of the gamma-ray spectrum has been determined in the 4 MeV < E < 12 MeV range and its dependence on the projectile mass has been established. Broad bumps have been oserved in the E > 12 MeV energy region. The possible correspondence between these bumps and the gamma-decay of giant dipole resonance built on highly excited states of compound nuclei and projectiles is discussed. 19 refs.; 5 figs.; 1 tab.

21622 (INIS-SU—386, pp 29-37) **Ratio of cumulative pion yields of different sign in proton-nucleus interaction at the proton energy from 17.5 to 63 GeV.** Belyaev, I.M.; Gavrishchuk, O.P.; Zolin, L.S.; Karev, A.G.; Lobanov, V.V.; Sukhanov, A.Yu. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki; Joint Inst. for Nuclear Research, Dubna, USSR). 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780087. (N—8-85).

In JINR rapid communications. Collection.

The data of the investigation of ratio of yields of cumulative pions of different sign are presented. Results are presented of a study of the ratio of the yields of $\pi$/sup +/ and $\pi$/sup -/ mesons at 159 deg angle in the p+/sup 90/Mo -> $\pi$sup(+-)+X reaction for 17.5<=Esub(p)<=63 GeV proton energy. It is shown that the ratio of the yields of hard pions (qsub($\pi$) > or approximately 300 MeV/c) over this energy range is approximate to 1. The behaviour is discussed of the $\pi$/sup -//$\pi$/sup +/ ratio for the interval of pion momenta 300 <= qsub($\pi$) <= 900 MeV/c. The results obtained are compared with the data of other experiments.

**21623 (INIS-SU—399) Experimental and theoretical data. Collection.** (AN SSSR, Moscow. Fizicheskij Inst.). 1986. 40p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87780091.

Kratkie Soobshcheniya po Fizike. No. 4.

Separate abstracts were prepared for 4 papers in this book. (DWL)

**21624 (LA—10915-PR) Applied nuclear science research and development: Progress report, December 1, 1985-June 30, 1986.** Arthur, E.D.; Mutschlecner, A.D. (comps.). (Los Alamos National Lab., NM (USA)). Feb 1987. Contract W-7405-ENG-36. 129p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87006311.

The diverse theoretical and experimental research in the field of applied nuclear physics is reviewed by presenting brief synopses of each research project. These research projects are organized into sections dealing with the theory and evaluation of nuclear cross sections, nuclear cross-section processing and testing, neutron activation, fission products, actinides, and applications. 30 refs., 90 figs., 13 tabs. (DWL)

**21625 (LA-UR—87-219) Recent joint developments in cross-section uncertainty analysis at Los Alamos and EIR [Eidgenoessiches Institut fuer Reaktorforschung].** Davidson, J.W.; Dudziak, D.J.; Muir, D.W.; Stepanek, J.; Higgs, C.E. (Los Alamos National Lab., NM (USA); Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). 1986. Contract W-7405-ENG-36. 16p. (CONF-861250—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005098.

From IAEA advisory group meeting on nuclear data for fusion reactor technology; Dresden, German D.R. (1 Dec 1986).

This paper discusses recent developments and future plans for the SENSIBL code (the successor to the SENSIT[6] and SENSIT-2D[7] codes), along with associated covariance data and cross section libraries. 34 refs. (DWL)

**21626 (LBL—22379) Workshop on nuclear structure at moderate and high spin: Slide report.** (Lawrence Berkeley Lab., CA (USA)). Oct 1986. Contract AC03-76SF00098. 182p. (CONF-861077—Vugraphs). NTIS, PC A09. File Number DE87003622.

From Workshop on nuclear structure at moderate and high spin; Berkeley, CA, USA (13 Oct 1986).

The workshop was scheduled to coincide with the beginning of operation of a number of large arrays of Compton-suppressed germanium detectors. The workshop was divided into 14 sessions containing 3 presentations each. The topics of these sessions were superdeformation, heavy rare earths, single-particle configurations, band termination, continuum properties, light rare-earths, new techniques, high temperatures, transfer reactions, transition region, shapes, lifetimes, and moments. This publication consists of the slides used in all of the presentations at the workshop.

**21627 (SLAC-PUB—4119) [International workshop on few-body approaches to nuclear reactions, in tandem and cyclotron energy regions]: Concluding remarks.** Noyes, H.P. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Oct 1986. Contract AC03-76SF00515. 3p. (CONF-860832—10). NTIS, PC A02/MF A01; GPO Dep. File Number DE87004897.

From 11. international conference on few-body systems in particle and nuclear physics; Tokyo, Japan (24 Aug 1986).

The three body problem in nuclear physics is reviewed in light of recent theoretical and experimental developments.

**21628 Transition probability, B(E2)up-arrow, from the ground to the first-excited $2^+$ state of even-even nuclides.** Raman, S.; Malarkey, C.H.; Milner, W.T.; Nestor, C.W. Jr.; Stelson, P.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Atomic Data and Nuclear Data Tables;* **36**: No. 1, 1-96(Jan 1987). Contract AC05-84OR21400.

Adopted values for the reduced electric quadrupole transition probability, B(E2)up-arrow, from the ground state to the first-excited $2^+$ state of even-even nuclides are given in Table I. Values of tau, the mean life of the $2^+$ state, E, the energy, and $\beta_2$, the quadrupole deformation parameter, are also listed there. The ratio of $\beta_2$ to the value expected from the single-particle model is presented. The intrinsic quadrupole moment, Q/sub O/, is deduced from the B(E2)up-arrow value. The product E x B(E2)up-arrow is expressed as a precentage of the energy-weighted total and isoscalar E2 sum-rule strengths.

**21629 Average transverse momentum and energy density in high-energy nucleus-nucleus collisions.** Burnett, T.H.; Dake, S.; Fuki, M.; Gregory, J.C.; Hayashi, T.; Holynski, R.; Iwai, J.; Jones, W.V.; Jurak, A.; Lord, J.J.; and others. (Institute for Cosmic Ray Research, University of Tokyo, Tanashi, Tokyo 188, Japan; Department of Physics, Kobe University, Kobe 657, Japan; Okayama University of Science, Okayama 700, Japan; Department of Applied Mathematics, Osaka University, Osaka 560, Japan; Science and Engineering Research). *Physical Review Letters;* **57**: No. 26, 3249-3252(29 Dec 1986).

Emulsion chambers were used to measure the transverse momenta of photons or $\pi^0$ mesons produced in high-energy ($\geq$1 TeV/amu) cosmic-ray nucleus-nucleus collisions. A group of events having large average transverse momenta have been found which apparently exceed the expected limiting values. Analysis of the events at early interaction times, of the order of 1 fm/c, indicates that the observed transverse momentum increases with both rapidity density and energy density.

## 6511 Experimental Techniques

*REFER ALSO TO CITATION(S) 21618*

## 6512 Nuclear Properties And Reactions, A=1-5, Experimental

**21630 (IAE—4041/12) Influence of the process (dμ)sub(n)+t -> d+(tμ)sub(n) on the kinetics of muon catalysis in a mixture D/sub 2/+T/sub 2/.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 7p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700876.

Influence of (dsub(μ))sub(n)+t -> d+(tsub(μ))sub(n) quasiresonance charge-exchange interaction process from dsub(μ) atom n <= 5 excited state into similar tsub(μ) atom state on the kinetics of muon catalysis in D/sub 2/+T/sub 2/ mixture is considered. 11 refs.; 3 figs.

**21631 (ITEF—163(1984)) Elastic and quasi-elastic /sup 3/Hep scattering at /sup 3/He nucleus momentum of 2.5 GeV/c.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1984. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700983.

Differential cross sections of elastic, quasielastic /sup 3/Hep scattering as well as mean energy losses of fast protons in the p+sup(3)He -> psub(F)+X reaction are obtained by means of the ITEP liquid-hydrogen bubble chamber 80 cm in diameter exposed in a beam of /sup 3/He nuclei with 2.5 GeV/c momentum (kinetic energy of primary protons in the system of nucleus rest Tsub(p)=0.318 GeV). Experimental data are compared with predictions of Glauber-Sitenko theory of multiple scattering. 5 refs.; 3 figs.; 1 tab.

**21632 Erratum: isospin dependence of pion absorption on nucleon pairs.** Silbar, R.R.; Piasetzky, E. *Physical Review [Section] C: Nuclear Physics;* **30**: No. 4, 1365(Oct 1984).

The relative sign between the NN′ and NΔ intermediate states was incorrect in the computer code that produced the predictions in this paper. Correcting this error makes negligible changes in the predictions of $\sigma_1$, the cross section for absorption by T = 0 NN pairs. The angle-averaged ratio R (Fig. 3) is also negligibly affected by this correction. The major effect of this sign error is to reverse the asymmetry of the T = 1 cross section $\sigma_3$(theta) about

theta = $\pi/2$. An example of this is shown for T/sub $\pi$, lab/=255 MeV. Note that the authors prediction in the paper of a prominent backward peaking in R (theta) at this energy now becomes, as corrected, a prediction for strong forward peaking. At T/sub $\pi$,lab/ =65 MeV the asymmetry is now in agreement with the observed backward-peaked cross section, but the predicted angular distribution is still flatter than the data.

## 6513 Nuclear Properties And Reactions, A=6-19, Experimental

21633 **(ITEF—5(1985)) Proton, neutron and deuteron yields from different nuclei including separated Li, B, Ni, Sn isotopes.** Bayukov, Yu.D.; Vlasov, A.V.; Gavrilov, V.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 67p. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87700965.

The tables of cross-sections of proton production with energies 70-230 MeV, neutron production with energies 75-190 MeV, deuteron production with energies 90-230 MeV for reaction pA -> hX at 7.5 GeV/c, $\pi$/sup -/A -> hX at 5 GeV/c for /sup 6/Li, /sup 7/Li, Be, /sup 10/B, /sup 11/B, C, F, /sup 58/Ni, Ni, /sup 64/Ni, Cu, Zn, /sup 112/Sn, Sn, /sup 124/Sn, In nuclei are presented. Proton and deuteron yields are measured at the angles of 30 deg, 60 deg, 88 deg, 119 deg, 160 deg and neutron yields - at the angles of 60 deg, 88 deg, 119 deg. 9 refs.; 5 tabs.

21634 **(ITEF—30(1985)) Inelastic scattering of 130MeV K/sup +/-mesons on light nuclei with proton escape.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 13p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700967.

A(K/sup +/,K/sup +/p) reaction on light nuclei (C, N, O) of photoemulsion is experimentally studied for the first time. Integral cross section of the reaction, momentum and angular distributions of residual nuclei, energy proton spectrum, differential cross section of K/sup +/-meson scattering, some other characteristics of the reaction are obtained. Experimental distributions are compared with calculations by the model of direct knock-out as well as with similar data for ($\pi$sup(+-), $\pi$sup(+-)p) reactions at 170 MeV. Main contribution to the cross section of the investigated reaction is shown to be produced by the mechanism of direct proton knock out. Estimation of the contribution of two-stage mechanism is carried out. 8 refs.; 7 figs.

21635 **(ITEF—60(1984)) Manifestation of narrow maximum in the impulse distribution of $\pi$ mesons from the $\pi$/sup +/+A(C,Xe)->$\pi$/sup +-/+kp(k=0,1,2...)+A' reactons.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1984. 20p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700971.

The assumption, that $\pi$/sup -/ mesons shaping a narrow peak in a momentum sectrum in the range of small momenta from the $\pi$/sup +/+C -> $\pi$/sup -/+kp (k=0, 1, 2...)+A', $\pi$/sup +/+Xe -> $\pi$/sup -/+kp (k=0, 1, 2...)+A' are produced as a result of highly excited nucleus state decay, is discussed. The $\pi$/sup +/C -> $\pi$/sup +/ (barkward) +kp (k=0, 1, 2...+A)', $\pi$/sup +/+Xe -> $\pi$/sup +/(barkward)+kp (k=0, 1, 2...)+A7 at the momentum of incidence $\pi$/sup +/ meson equal to 2.9 GeV/c are studied for testing this assumption. Photographs are obtained in the 120 l propane-xenon ITEP chamber placed in a magnetic field. Existence of the $\pi$/sup +/ narrow peak is proved in the Psub($\pi$)sup(+) < 740 MeV/c momenta range. Different mechanisms permitting to explain this experimentally obtained phenomenon are analyzed. 3 refs. ; 8 figs.

21636 **(ITEF—96(1985)) Analysis of dependence on target nucleus mass number of spectrum shapes and angular distributions of protons produced in hadron-nucleus interactions.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 16p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700974.

Spectrum and angular distribution shapes of protons, produced in the $\pi$(5 GeV/s) and P(7,5 GeV/s) interactions with /sup 6/Li, /sup 7/Li, Be, /sup 10/B, /sup 11/B, C, F, Ni, Cu, Zn, In, Sn nuclei are analysed. It is shown that cumulative proton angular distribution and spectrum shapes do not depend on the target nucleus mass number with the accuracy of approximately 5% and approximately 1% respectively. 12 refs.; 8 figs.

21637 **Correlations between $\alpha$ particles and evaporation residues for the /sup 14/N+/sup 12/C reaction at E(/sup 14/N) = 180 MeV.** Gomez del Campo, J.; DiGregorio, D.E.; Biggerstaff, J.A.; Chan, Y.D.; Hensley, D.C.; Stelson, P.H.; Shapira, D.; Ortiz, M.E. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review [Section] C: Nuclear Physics;* **35**: No. 1, 137-140(Jan 1987). Contract AC05-84OR21400.

Angular correlations between $\alpha$ particles and evaporation residues have been measured to study the equilibrium versus nonequilibrium effects on the fusion process. Measurements with $\alpha$-particle detectors were carried out to extreme forward angles (4°) to maximize the sensitivity to nonequilibrium components. The results are consistent with complete fusion and equilibrium decay, in contrast with recent systematics that predict large amounts of incomplete fusion at this energy.

## 6514 Nuclear Properties And Reactions, A=20-38, Experimental

21638 **Direct mass measurements of neutron-rich light nuclei near N = 20.** Vieira, D.J.; Wouters, J.M.; Vaziri, K.; Kraus R.H. Jr.; Wollnik, H.; Butler, G.W.; Wohn, F.K.; Wapstra, A.H. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review Letters;* **57**: No. 26, 3253-3256(29 Dec 1986).

The simultaneous direct mass measurements of 21 neutron-rich nuclei ranging from /sup 19/C to /sup 37/P have been performed with a new type of recoil spectrometer. The masses of /sup 19/C, /sup 27//sup —//sup 28/Ne, /sup 32//sup —//sup 34/Al, /sup 36/Si, and /sup 37/P have been determined for the first time. No evidence of an increase in the two-neutron separation energy as noted for /sup 31//sup —//sup 32/Na is observed for /sup 30//sup —//sup 32/Mg and /sup 32//sup —//sup 34/Al.

## 6515 Nuclear Properties And Reactions, A=39-58, Experimental

21639 **(CEA-CONF—8566) Nuclear medium effects in $^{40}$Ca(e, e', p)$^{39}$K experiment.** Bernheim, M.; Gerard, A.; Magnon, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Aug 1986. 2p. (CONF-860802—13-Summ.). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751042.

From International nuclear physics conference; Harrogate, UK (25 Aug 1986).

Published in summary form only.

21640 **(INIS-mf—10565, pp 46-49) Study on cross sections of ultracold neutron interaction with the /sup 58/Ni ferromagnetic.** Antonov, A.V.; Isakov, A.I.; Kuznetsov, S.P.; Perekrestenko, A.D. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780085.

Kratkie Soobshcheniya po Fizike. No. 3.

In Experimental and theoretical physics. Collection.

Total cross sections of neutron interaction with /sup 58/Ni were studied using the ultracold neutron (UCN) spectrometer at

sample temperatures of 298 and 80 K and also under the action of a magnetic field with 116-1064 Oe intensity. It follows from the experiments with magnetic field that elastic UCN scattering is primarily determined by scattering on nonuniformities of a magnetic nature. Presence of elastic scattering of neutrons with a velocity < 30 m/s in the magnetic field corresponding to saturation magnetization (H=600, 1064 Oe) points to the fact, that nonuniformities of a nonmagnetic nature with sizes about an order of UCN wavelength probably exist in this sample.

21641 **Beta-delayed proton decay of /sup 61/Ge.** Hotchkis, M.A.C.; Reiff, J.E.; Vieira, D.J.; Bloennigen, F.; Lang, T.F.; Moltz, D.M.; Xu, X.; Cerny, J. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Physical Review [Section] C: Nuclear Physics;* **35**: No. 1, 315-319(Jan 1987). Contract AC03-76SF00098.

The T/sub z/ = -(3/2), A = 4n+1 nuclide /sup 61/Ge has been produced via the /sup 40/Ca(/sup 24/Mg,3n) reaction and identified by its beta-delayed proton emission. A single proton group at 3.11 +- 0.03 MeV with t/sub 1/2/ = 40 +- 15 ms has been observed, corresponding to decay of the T = (3/2) isobaric analog state in /sup 61/Ga to the ground state of /sup 60/Zn. Searches for the beta-delayed proton decay of the next member of this series, /sup 65/Se, to be produced by the /sup 40/Ca(/sup 28/Si,3n) reaction, have proven unsuccessful.

## 6516 Nuclear Properties And Reactions, A=59-89, Experimental

21642 (INIS-SU—395, pp 11-18) **On some peculiarities of central collisions of 4.1 AxGeV/c momentum neon 22 nuclei with nuclei in photoemulsion.** Krasnov, S.A.; Tolstov, K.D.; Shabratova, G.S. (Joint Inst. for Nuclear Research, Dubna, USSR. Lab. of High Energy). 1986. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780088. (N—16-86).

In JINR rapid communications. Collection.

Some peculiarities of 259 central collision events selected among 4309 inelastic interactions of neon 22 nuclei with nuclei in photoemulsion have been investigated. The correlations between the multiplicities of different types of the secondaries become less in comparison with the analogous ones for all inelastic interactions. At the same time the coefficients of pseudorapidity correlations for particles with $\beta>0.7$ differ from zero. A wide maximum in the angular distribution for slow particles- products of target nucleus disintegration is observed. 18 events have been selected from 243 events of the central collisions with the silver and bromine nuclei. In these interactions at a large number of fast charged particles (of about 40) the emission of such particles with angles up to 6-12 deg relative to the primary nucleus direction is not observed. The probability of random appearance of these events does not exceed 10/sup -3/. 2 refs.; 2 figs.; 3 tabs.

## 6517 Nuclear Properties And Reactions, A=90-149, Experimental

21643 **(IAE—4144/2) Study on the /sup 90/Zr(/sup 6/Li,/sup 6/He)/sup 90/Nb reaction at Esub(sup(6) Li) = 93 MeV.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 32p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87700882.

Energy spectra /sup 6/He from /sup 90/Zr(/sub 6/Li, /sup 6/He) reaction at Esub(Li)=93 MeV at different angles in the range of THETAsub(lab.syst.)=7-20 deg are measured. The spectrum and angular distribution theoretical analysis is carried out within the framework of the distorted wave method using transitional densities of bound and resonance states, found on the basis of finite Fermi-system theory. It is shown, that the quasi-elastic direct recharging mechanism dominates in the reaction up to excitation energies Esub(x) approximately 10 MeV in /sup 90/Nb, and in the high Esub(x) range the multistage process contribution increases sharply. It is also shown, that the quasi-elastic cross section is determined by the partial contribution sum of a large spin-isospin flip transition number with multipolarity L from 0 up to approximately 6. 50 refs.; 12 figs.

21644 (INIS-SU—399, pp 19-21) **Interaction of low-energy neutrons with tellurium isotopes.** Musaelyan, R.M.; Ovdienko, V.D.; Sklyar, N.T.; Skorkin, V.M.; Fedorov, M.B.; Yakovenko, T.I. 1986. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87780091.

Kratkie Soobshcheniya po Fizike. No. 4.

In Experimental and theoretical data. Collection.

Total neutron cross sections of sup(122,124,126,128,130)Te isotopes are obtained for 0.41-2.16 MeV energy range. These data are analyzed on the basis of different variants of the generalized optical model. The optical potential real part had the radial Woods-Saxon dependence. The potential imaginary part was taken in the form of the Woods-Saxon form-factor derivative and spinorbit interaction - in the Thomas form. 10 refs.; 2 figs.

21645 **Neutron emission in the fissioning /sup 158/Er composite system.** Gavron, A.; Gayer, A.; Boissevain, J.; Britt, H.C.; Awes, T.C.; Beene, J.R.; Cheynis, B.; Drain, D.; Ferguson, R.L.; Obenshain, F.E. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review [Section] C: Nuclear Physics;* **35**: No. 2, 579-590(Feb 1987).

We have measured the spectra and angular distribution of neutrons emitted in coincidence with fission fragments in the following reactions: /sup 16/O+ /sup 142/Nd (E/sub beam/ = 207 MeV), /sup 24/Mg+ /sup 134/Ba (180 MeV), /sup 32/S+ /sup 126/Te (180 MeV), and /sup 50/Ti+ /sup 108/Pd (216 MeV). We decompose neutron emission into components resulting from nonequilibrium emission, emission from the compound system, and emission from the fission fragments. We find that statistical model calculations tend to underestimate the number of neutrons evaporated prior to fission. Incorporating the effects of (1) the finite time until equilibrium fission probability is attained at the saddle point, (2) correction to the Bohr-Wheeler formalism due to nuclear viscosity, and (3) neutron emission during the descent from saddle to scission, improves the agreement with the experimental data. The value of the reduced nuclear dissipation coefficient $\beta$ that is consistent with our data is approximately 6 x 10/sup 21/ s/sup -1/, within the framework of the model we have used.

21646 **Investigation of A = 152 radioactivities with mass-separated sources: Identification of /sup 152/Lu.** Toth, K.S.; Sousa, D.C.; Nitschke, J.M.; Wilmarth, P.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review [Section] C: Nuclear Physics;* **35**: No. 1, 310-314(Jan 1987). Contract AC05-84OR21400.

Nuclides with A = 152 were produced in /sup 58/Ni bombardments of /sup 96/Ru and their decay properties were investigated following on-line mass separation. The isotope /sup 152/Lu (T/sub 1/2/ = 0.7 +- 0.1 s) was identified by $\gamma$ rays in its $\beta$-decay daughter, /sup 152/Yb. Based on its decay characteristics, the parent state has a probable spin and parity assignment of ($4,5,6^-$). Several new transitions were observed to follow the $\beta$ decays of /sup 152/Yb and the /sup 152/Tm low-spin isomer; they established previously unknown levels in both /sup 152/Tm and /sup 152/Er. The additional $\gamma$ rays in /sup 152/Yb decay reduce from 100% to 88% the direct feeding to the one excited state in /sup 152/Tm that had been known earlier. Nevertheless, the corresponding logft value is calculated to be 3.5, indicating that this is an allowed $\beta$ transition which connects the $0^+$ parent with a $1^+$ excited state in /sup 152/Tm. By comparing the $\beta$-decay rates of /sup 148/Dy and /sup 152/Ho, and the $\alpha$- and $\beta$-decay rates of /sup 152/Er, an $\alpha$ branch of 90 +- 4 % was deduced for /sup 152/Er.

21647 **Octupole deformation in neutron-rich barium isotopes.** Phillips, W.R.; Ahmad, I.; Emling, H.; Holzmann, R.; Janssens, R.V.F.; Khoo, T.h.; Drigert, M.W. (Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review Letters;* **57**: No. 26, 3257-3260(29 Dec 1986). Contract W-31-109-ENG-38.

Partial decay schemes for the very neutron-rich nuclei /sup 142,144/Ba and /sup 146/Ba have been determined by the study of

γ-γ coincidences in /sup 252/Cf fission fragments. Interlaced positive- and negative-parity levels connected by fast electric dipole transitions are observed in /sup 144/Ba and /sup 146/Ba above spin 7h-dash-bar. This is similar to the situation in some light actinide nuclei, where the data have been interpreted in terms of reflection-asymmetric shapes.

21648 **Large-scale shell model calculations for odd-odd nuclei and comparison to experimental studies of fission product nuclei in the /sup 132/Sn region.** Lane, S.M.; Henry, E.A.; Meyer, R.A. (Lawrence Livermore National Lab., Livermore, CA 94550). pp 676-705 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

Experimental spectroscopy data of fission products have been obtained using highly automated and rapid chemical separations followed by automated spectroscopy studies of isolated fission products. These data have established the presence of only a single level with spin-parity of 1/sup +/ below 1500 keV of excitation in Z=51 /sup 132/Sb/sub 81/. This is in contrast to the results of studies of /sup 130/Sb and /sup 134/I. For /sup 134/I, the N=81 isotone with Z=53, the authors can characterize three 1/sup +/ levels below 1200 keV. For /sup 130/Sb/sub 79/ that has a neutron pair less than /sup 132/Sb, we can identify two 1/sup +/ levels below 1100 keV. The authors can account for the additional levels using the LLNL shell-model code which is based on the Lanczos tridiagonalization algorithm using an uncoupled m-scheme basis and vector manipulations. The 1g/sub 7/2/, 2d/sub 5/2/, 2d/sub 3/2/, 1h/sub 11/2/, and 3s/sub 1/2/ orbitals are available to the valence protons and the 2d/sub 5/2/, 2d/sub 3/2/, 1h/sub 11/2/, and 3s/sub 1/2/ orbitals are available to the valence neutron holes. Analysis of the wavefunctions show the dominant role of three nucleon cluster configurations in producing the increased number of states at low energy. The absence of nucleon cluster configurations in the parent nucleus /sup 130/Sn is used to explain the reduction in the Gamow-Teller beta strength to the low lying 1/sup +/ levels of /sup 130/Sb.

21649 **Bayman, Ellis and Tang respond.** Bayman, B.F.; Ellis, P.J.; Tang, Y.C. (Univ. of Minnesota, Minneapolis). *Physical Review Letters;* **50**: No. 3, 216(17 Jan 1983). Contract AC02-79ER10364.

MacGregor have raised several important issues relevant to the experimental evidence for the existence of anomalons, and to their suggestion that anomalons may be deformed quasimolecular resonances (QMR). These issues are briefly discussed.

## 6518 Nuclear Properties And Reactions, A=150-189, Experimental

21650 **Distributions of the total energy and multiplicity of gamma rays feeding the discrete yrast states in heavy-ion-induced fusion reactions.** Lee, I.Y.; Baktash, C.; Beene, J.R.; Fewell, M.P.; Halbert, M.L.; Johnson, N.R.; McGowan, F.K.; Milner, W.T.; Kim, H.J.; Sayer, R.O. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review [Section] C: Nuclear Physics;* **35**: No. 2, 605-613(Feb 1987). Contract AC05-84OR21400;AC02-76ER04052.

The distribution of the total energy and multiplicity of gamma rays feeding the yrast transitions has been measured for /sup 158,159/Er, /sup 130/Ce, and /sup 116,117/Te, which are produced in several heavy-ion fusion reactions. The observed shape of the distribution feeding discrete yrast states varies with the spin of the yrast transition. However, the differences are small, especially for heavier-ion induced reactions.

21651 **Decay properties of /sup 150/Tm and /sup 150/Er.** Toth, K.S.; Sousa, D.C.; Nitschke, J.M.; Wilmarth, P.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review [Section] C: Nuclear Physics;* **35**: No. 2, 620-624(Feb 1987). Contract AC05-84OR21400;AC03-76SF00098.

The decay properties of /sup 150/Tm and /sup 150/Er (produced in /sup 58/Ni bombardments of /sup 96/Ru) were investigated following on-line mass separation. The half-life of /sup 150/Tm was measured to be 2.2 +- 0.2 s rather than the value of 3.5 s available in the literature. Based on its decay characteristics, we suggest that this high-spin /sup 150/Tm isomer has a spin assignment of $6^-$. Among the /sup 150/Er states fed by this $6^-$ isomer is the yrast $4^+$ level (2294.8 keV) which up to now has been observed in neither β-decay nor in-beam γ-ray studies. New transitions observed in /sup 150/Er decay establish several previously unknown levels in /sup 150/Ho. While the additional γ rays reduce from 100% to 96% the feeding to the 476-keV state in /sup 150/Ho known earlier, the corresponding logft value is calculated to be 3.6, indicating that this is an allowed, $0^+ \rightarrow 1^+$, beta transition. Photon intensities obtained for γ rays following the decay of the /sup 150/Ho low-spin isomer resolve inconsistent values measured in two previous investigations.

21652 **Fission induced in /sup nat/U, /sup nat/Pb, /sup 197/Au, and /sup 165/Ho by 80 and 100 MeV πi and $\pi^-$.** Khan, H.A.; Khan, N.A.; Peterson, R.J. (Solid State Nuclear Track Detector Laboratory, Nuclear Engineering Division, Pakistan Institute of Nuclear Science and Technology, Rawalpindi, Pakistan). *Physical Review [Section] C: Nuclear Physics;* **35**: No. 2, 645-650(Feb 1987).

Solid state nuclear track detectors having different detection thresholds have been employed to study the fission fragments and the light charged particles emitted in the interaction of 80 and 100 MeV π/sup +- / with targets of /sup nat/U, /sup nat/Pb, /sup 197/Au, and /sup 164/Ho. Cross sections for the production of correlated fission fragments (and other heavy charged particles)= and the unpaired single charged particles were obtained in different Z and Z/β domains. Energies and masses of the reaction products are estimated. Angular correlations of the reaction products have also been obtained. A large fraction of protons and (to a lesser extent) alpha particles are found to be emitted in these interactions. It has been found that distributions of the fission fragments are only slightly anisotropic and that their mass distributions are wider than those obtained for nucleon-induced fission having similar excitation energies. The results have been compared with the scanty data available on the subject and with systems having comparable excitation energies.

21653 **Lifetime measurements of high-spin states in /sup 166/Yb.** Bacelar, J.C.; Holm, A.; Diamond, R.M.; Beck, E.M.; Deleplanque, M.A.; Draper, J.; Herskind, B.; Stephens, F.S. (Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Physical Review Letters;* **57**: No. 24, 3019-3022(15 Dec 1986). Contract AC03-76SF00098.

The Doppler-shift attenuation method was used to measure lifetimes of yrast states in /sup 166/Yb. Values of tau range from 0.16(2) ps at $24^+$ to 0.05(1) ps at $34^+$. The B(E2) values decrease from 240 to 120 single-particle units in this spin range, indicating a loss of collectivity which likely reflects a change of the nucleus towards triaxial shape. The side-feeding times are consistent with rotational cascades having moments of inertia 25% larger than the yrast sequence or B(E2) values around 60 single-particle units.

21654 **Incomplete and complete fusion in intermediate energy heavy ion reactions.** Aleklett, K.; Loveland, W.; Sugihara, T.T.; Behkami, A.N.; Morrissey, D.J.; Wenxin, L.; Kot, W.; Seaborg, G.T. (Studsvik Neutron Research Lab., Nykoeping, Sweden; Oregon State Univ., Corvallis, USA; Michigan State Univ., East Lansing, USA; Lawrence Berkeley Lab., CA, USA). *Physica Scripta;* **34**: No. 6A, 489-494(Dec 1986).

The yields, angular distributions and differential range spectra have been measured for individual target residues from the interaction of 8.5 MeV/A /sup 16/O, 19 MeV/A /sup 16/O, 35 MeV/A /sup 12/C and 85 MeV/A /sup 12/C with /sup 154/Sm. From the measured data, fragment isobaric yields and velocity spectra were deduced. The results are compared to the predictions of a modified Boltzmann master equation model of precompound particle emission.

## 6519 Nuclear Properties And Reactions, A=190-219, Experimental

**21655 (CONF-850942—59) Signature splitting in $^{135}$Pr.** Semkow, T.M.; Sarantites, D.G.; Honkanen, K.; Abenante, V.; Baktash, C.; Johnson, N.R.; Lee, I.Y.; Oshima, M.; Schutz, Y.; Chen, C.Y. (Washington Univ., St. Louis, MO (USA); Oak Ridge National Lab., TN (USA); Pittsburgh Univ., PA (USA); Tennessee Univ., Knoxville (USA); Brookhaven National Lab., Upton, NY (USA)). 1985. Contract AC05-84OR21400. 7p. NTIS, PC A02. File Number DE87005977.

From 190. American Chemical Society national meeting; Chicago, IL, USA (8 Sep 1985).

In-beam spectroscopic study of $^{135}$Pr was made using 91 MeV $^{120}$Sn($^{19}$F,4n) reaction. A strong negative parity proton band based on the h/sub 11/2$^-$/ 1/2[550] configuration with $\alpha$ = -1/2 was observed. Possibly $\alpha$ = +1/2 unfavored band is observed. Also two positive parity proton bands are observed most likely based on the g/sub 7/2$^+$/ 5/2[413] configurations with $\alpha$ = +-1/2. In all cases (except for the ($\pi$,$\alpha$) = (-,+1/2) band) the backbending is caused by alignment of two h/sub 11/2$^-$/ 9/2[514] quasi-neutrons. For the strongly decoupled $\pi$(-) bands the observed signature splitting decreases with increasing rotational frequency. The signature splitting of the positive parity bands increases with rotational frequency and then inverts above the backbending. This is interpreted to be caused by the quasi-neutrons, which drive the $\gamma$-deformation to the negative values. 18 refs., 6 figs.

**21656 (HMI-P—86/7-HF-Prepr.) In-beam measurements of nuclear moments.** Mahnke, H.E. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.)). 1986. 13p. (CONF-860918—). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751286.

From 7. international conference on hyperfine interactions; Bangalore, India (8 Sep 1986).

Nuclear moments contribute valuable information to nuclear structure studies of nuclei under extreme conditions, such as nuclei at high angular momentum or far from stability. While the magnetic moment is sensitive to the nature of the participating nucleons (neutron or proton) the quadrupole moment is a direct measure for nuclear deformation.

**21657 Nuclear Data Sheets for A = 201.** Schmorak, M.R. (Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee 37831). *Nuclear Data Sheets;* **49**: No. 4, 733-784(Dec 1986). Contract AC05-84OR21400.

Experimental data pertaining to nuclei with A = 201 are compiled and evaluated. Ccopyright 1986 by Academic Press, Inc.

## 6520 Nuclear Properties And Reactions, A=220 And Above, Experimental

**21658 Nuclear structure of /sup 231/Th from neutron capture and (d,p) reaction measurements.** White, D.H.; Boerner, H.G.; Hoff, R.W.; Schreckenbach, K.; Davidson, W.F.; von Egidy, T.; Warner, D.D.; Jeuch, P.; Barreau, G.; Kane, W.R. (Institut Laue-Langevin, 38042 Grenoble, France and Lawrence Livermore National Laboratory, Livermore, California 94550). *Physical Review [Section] C: Nuclear Physics;* **35**: No. 1, 81-110(Jan 1987). Contract W-7405-ENG-48.

The nuclide /sup 231/Th was investigated with the reactions /sup 230/Th(n,$\gamma$) /sup 231/Th, /sup 230/Th(n,$\gamma$e)/sup 231/Th, and /sup 230/Th(d,p)/sup 231/Th. Gamma rays from average resonance capture were measured, in addition to the usual thermal neutron capture spectroscopy. From these data, 70 excited levels in / sup 231/Th were identified and, of these, 57 were placed in 18 rotational bands with assigned configurations. Candidates have been proposed for all expected Nilsson states below 750 keV, albeit with varying degrees of confidence, including the (5/2)$^+$[622], (7/2)$^+$[624], (3/2)$^-$[761], (1/2)$^-$[770], (1/2)$^+$[640], and (5/2)$^-$[503] configurations. Several vibrational states have been identified; a special feature of these is the observation of greater fragmentation of single-particle-0$^+$ phonon-mixed states than expected theoretically. Assuming degenerate parity doublets indicate the existence of stable octupole deformation, no evidence was found for a tendency toward this phenomenon in /sup 231/Th. The neutron binding energy was determined to be 5118.13 +- 0.20 keV.

**21659 Dependence of actinide production on the mass number of the projectile: Xe +/sup 248/Cm.** Welch, R.B.; Moody, K.J.; Gregorich, K.E.; Lee, D.; Seaborg, G.T. (Nuclear Science Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Physical Review [Section] C: Nuclear Physics;* **35**: No. 1, 204-212(Jan 1987). Contract AC03-76SF00098.

Production cross sections for actinide nuclides formed in the reactions of 791—769 MeV /sup 129/Xe and 817—793 MeV /sup 132/Xe with /sup 248/Cm were measured using radiochemical techniques to isolate elements 93 to 100 (Np to Fm). These results were compared with previous results from the reaction of 790—699 MeV /sup 136/Xe with /sup 248/Cm. The production cross section distributions of target-like nuclides for a given Z appear to shift to smaller A with the use of the more neutron-deficient projectiles. The production of nuclides with Z>Z/sub target/ increases at the expense of nuclides with Z<Z/sub target/ with use of the more neutron-deficient projectiles. The distribution of product cross sections from each reaction is treated as the sum of distributions of products from two reaction mechanisms, quasi-elastic transfer and deep inelastic transfer. Potential energy surfaces for the three reacting systems under discussion were calculated for touching sphere configurations and can be used to predict the production cross section trends. However, the peak position of the cross section distribution for a given Z is not accurately predicted by the potential energy surfaces, which suggests that deep inelastic transfer reactions may not be the dominant reaction mechanism, leading to the observed final distribution.

**21660 Measurement of the energy dependence of prompt fission neutron emission from /sup 233/U, /sup 235/U, and / sup 239/Pu for E = 0.0005 to 10 MeV relative to emission from spontaneous fission of /sup 252/Cf/sup */.** Gwin, R.; Spencer, R.R.; Ingle, R.W. (Oak Ridge National Lab., Oak Ridge, TN 37831). pp 589-592 of Nuclear data for basic and applied science. Volume 1. Young, P.G.; Brown, R.E.; Auchampaugh, G.F.; Lisowski, P.W.; Stewart, L. New York, NY; Gordon and Breach Science Publishers Inc. (1985). (CONF-850507—). Contract AC05-84OR21400.

From International conference on nuclear data for basic and applied science; Santa Fe, NM, USA (13 May 1985).

A series of experiments has been performed to measure the dependence on incident neutron energy of $\nu$-bar/sub rho/(E), the average number of prompt neutrons emitted per fission, of /sup 233/U, /sup 235/U, and /sup 239/Pu relative to $\nu$-bar/sub rho/ (/ sup 252/Cf), the average number of prompt neutrons emitted in spontaneous fission of /sup 252/Cf. The incident energy range was 0.0005 to 10 MeV. A white neutron source was generated by the Oak Ridge Electron Linear Accelerator and the energies of the neutrons incident on the fissile samples were determined by time-of-flight techniques. The fissile sample and the /sup 252/Cf standard were contained in a fission chamber surrounded by a large volume (0.91 m/sup 3/) liquid scintillator loaded with gadolinium. Fissions were detected by the fission chamber and the neutrons were detected by the scintillator.

**21661 Status of fast neutron nuclear data for /sup 239/Pu.** Arthur, E.D. (Los Alamos National Lab., Los Alamos, NM). pp 445-457 of Nuclear data for basic and applied science. Volume 1. Young, P.G.; Brown, R.E.; Auchampaugh, G.F.; Lisowski, P.W.; Stewart, L. New York, NY; Gordon and Breach Science Publishers Inc. (1985). (CONF-850507—).

From International conference on nuclear data for basic and applied science; Santa Fe, NM, USA (13 May 1985).

Recent energy-averaged data (fission, total cross section, scattering and v-bar/sub rho/) describing the interaction of fast neutrons with /sup 239/Pu are discussed, with emphasis on neutron energies higher than the inelastic scattering threshold. The linkage between such experimental data and new theoretical calculations is described in context of their influence on a new revision to the

ENDF/B-V /sup 239/Pu evaluation. Results from this new revision are compared with other current /sup 239/Pu evaluations. Incorporation of such information pertaining to neutron emission and v-bar/sub rho/ in the new ENDF revision had a profound impact on calculations performed for fast critical assemblies. Such calculational results are presented with emphasis on systematic improvements achieved in eigenvalues and fission ratios.

## 6530 Nuclear Theory

*REFER ALSO TO CITATION(S) 21438, 21535, 21619, 21620, 21624, 21626, 21627, 21648, 21833, 22028, 22029*

21662 **(CONF-8603115—4) Quantum mechanics and spectrum generating groups and supergroups.** Bohm, A. (Texas Univ., Austin (USA). Center for Particle Theory). Apr 1986. Contract FG05-85ER40200. 17p. (CPT—0057). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004491.

From Symmetries in science II; Carbondale, IL, USA (24 Mar 1986).

Collective models are reviewed briefly as the physical basis for dynamical groups, particularly for molecular and nuclear physics. To show that collective models for extended relativistic objects can be constructed, the results of a quantal relativistic oscillator are reviewed. An infinite supermultiplet is then used to describe Regge recurrences as yrast states and daughters as radial excitations. (LEW)

21663 **(CONF-8609235—1) Measurement of low energy neutrino absorption probability in thallium 205.** Freedman, M.S. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 28p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87004655.

From International conference on solar neutrino detection with /sup 205/T1 and related topics; Dubrovnik, Yugoslavia (29 Sep 1986).

A major aspect of the P-P neutrino flux determination using thallium 205 is the very difficult problem of experimentally demonstrating the neutrino reaction cross section with about 10% accuracy. One will soon be able to completely strip the electrons from atomic thallium 205 and to maintain the bare nucleus in this state in the heavy storage ring to be built at GSI Darmstadt. This nucleus can decay by emitting a beta-minus particle into the bound K-level of the daughter lead 205 ion as the only energetically open decay channel, (plus, of course, an antineutrino). This single channel beta decay explores the same nuclear wave functions of initial and final states as does the neutrino capture in atomic thallium 205, and thus its probability or rate is governed by the same nuclear matrix elements that affect both weak interactions. Measuring the rate of accumulation of lead 205 ions in the circulating beam of thallium 205 ions gives directly the cross section of the neutrino capture reaction. The calculations of the expected rates under realistic experimental conditions will be shown to be very favorable for the measurement. A special calibration experiment to verify this method and check the theoretical calculations will be suggested. Finally, the neutrino cross section calculation based on the observed rate of the single channel beta-minus decay reaction will be shown. Demonstrating bound state beta decay may be the first verification of the theory of this very important process that influences beta decay rates of several isotopes in stellar interiors, e.g., Re-187, that play important roles in geologic and cosmologic dating and nucleosynthesis. 21 refs., 2 figs. (DWL)

21664 **(DOE/ER/10405—T12) Theoretical studies of multistep processes, isospin effects in nuclear scattering, and meson and baryon interactions in nuclear physics. Final technical report, 1 September 1979-30 April 1986.** Madsen, V.A.; Landau, R.H. (Oregon State Univ., Corvallis (USA). Dept. of Physics). 18 Sep 1986. Contract AT06-79ER10405. 21p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87000341.

Final technical report on a contract supporting theoretical studies in nuclear physics at Oregon State University is presented. The research was led by Professors Landau and Madsen and carried out in collaboration with graduate students in Corvallis and scientists at LLNL-Livermore, KFA-Julich, Purdue University-West Lafayette, University of Oregon-Eugene, Florida State University-Talahasie, and TRIUMF-Vancouver. The studies included meson exchange current effects, quark effects,and relativistic/Dirac effects deduced from spin observables in p-$^3$He scattering, coupled bound and continuum eigenstates in momentum space for kaons and antiprotons, and charge symmetry violation in $\pi$ scattering from trinucleons. Additional studies included microscopic optical potential calculations, multiple step processes, and differences in neutron and proton multipole matrix elements in low lying collective states and in giant resonances. 45 refs.

21665 **(GSI—86-40-Prepr.) Evidence for multiparticle correlations in high-energy heavy ion interactions.** Beckmann, P.; Doss, K.G.R.; Gustafsson, H.A.; Gutbrod, H.H.; Kampert, K.H.; Kolb, B.; Loehner, H.; Poskanzer, A.M.; Ritter, H.G.; Schmidt, H.R. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.)). Oct 1986. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751293.

An exclusive approach is proposed to study azimuthal multiparticle correlations in heavy ion interaction. Strong many-particle correlations are found in relativistic heavy ion reactions measured with the Plastic Ball spectrometer. Energy, mass, and multiplicity dependence of the correlations are examined.

21666 **(GSI—86-41-Prepr.) New results from dissipative diabatic dynamics and nuclear elastoplasticity.** Noerenberg, W. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.)). Oct 1986. 13p. (CONF-8609159—5-Prepr.). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751269.

From International school-seminar on heavy ion physics; Dubna, USSR (23 Sep 1986).

I present new results about dissipative diabatic dynamics and nuclear elastoplasticity, in particular on a self-consistent diabatic formulation, on first numerical calculations of dissipative diabatic dynamics in two collective degrees of freedom, on quasi-elastic recoil in central nucleus-nucleus collisions, on the diabatic hindrance of fusion reactions and on the diabatic emission of nucleons in central nucleus-nucleus collisions. (orig./HSI).

21667 **(IAE—4048/2) Quantum mechanics and liquid drop model of nuclei.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 37p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700877.

The quantum-mechanical model calculations have been performed for a large group of intermediate, heavy and superheavy double-magic highly neutron-or proton-rich nuclei. It has been shown that the liquid drop model and binding energy formulas (of the Bethe-Weizacker type) based on this model after modification of the term describing the symmetry energy, agrees reasonably well with the calculation data within a wide region of A and Z variations. Interpolation formulas for nucleus radii, their compressibility and monopole radial oscillation energies (breathing mode) have been obtained too. The results have been found weakly dependent on the shapes of three different nucleon-nucleon potentials used in the calculations. 22 refs.; 12 figs.; 6 tabs.

21668 (INIS-SU—395, pp 5-10) **Fragmentation of one-quasiparticle states in sup(153, 155)Sm and sup(153, 155)Eu.** Malov, L.A.; Nguen Din' Vin'; Solov'ev, V.G. (Joint Inst. for Nuclear Research, Dubna, USSR. Lab. of Theoretical Physics). 1986. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780088. (N—16-86).

In JINR rapid communications. Collection.

Fragmentation is calculated for neutron 2fsub(7/2), 1hsub(9/2), 1isub(13/2), 3psub(3/2), 2fsub(5/2), 3psub(1/2), 2gsub(9/2) and proton 1gsub(7/2), 2dsub(5/2), 1hsub(11/2), 2dsub(3/2), 2fsub(7/2) subshells providing a dominant contribution to the cross sections of (a, /sup 3/He) and (a, t) reactions in the sup(152, 154)Sm isotopes. 7 refs.; 2 figs.

21669 (INIS-SU—398, pp 14-30) **Collective properties of even-even tellurium isotopes.** Kuznichenko, A.V.; Lebedev, V.N.; Onishchenko, G.M.; Alikov, B.A.; Nazmitdinov, R.G. 1985. (In Russian). NTIS (US Sales Only), PC A05/MF A01. File Number DE87780090.

In Problems of nuclear physics and cosmic rays. No. 23. Republican Interinstitute scientific technical collection.

Properties of the even-even /sup 118/-/sup 126/Te isotopes are investigated in the framework of the interacting boson approximation (IBA-1) model. Calculated excitation energies, E2 transition probabilities and quadrupole moments of the 2/sub 1//sup +/ states are compared with experiment. The collective features of these nuclei are found to be in satisfactory agreement with the predictions of the IBA. Clear deviations for relatively high states (1>=6/sup +/) could be related to an increasing importance two-quasiparticle components in the wave functions of these states. 21 refs.; 3 figs.; 2 tabs.

21670 (INIS-SU—398, pp 3-13) **On the inelastic scattering of 20 MeV polarized protons and 50 MeV $\alpha$-particles on some light and intermediate mass nuclei.** Plavko, A.V.; Kudryashov, V.I.; Lombar, R.M.; Ehskyud'e, Zh.L.; Dejsebaev, A.D.; Burtebaev, N.T. 1985. (In Russian). NTIS (US Sales Only), PC A05/MF A01. File Number DE87780090.

In Problems of nuclear physics and cosmic rays. No. 23. Republican Interinstitute scientific technical collection.

It is shown that in an inelastic scattering of polarized protons at an energy of about 20 MeV from a number of light nuclei a correlation is observed between the angular distributions of the analyzing power A(THETA) and the excitation energy of nuclear levels. This correlation is established to be in accordance with the nuclear structure. The experimental A(THETA) distributions are compared with coupled-channels calculations. The dependence of the A(THETA) distributions on the nuclear structure is found to be more marked than for the angular distributions $d\sigma/d\Omega$ in the (p,p') and (a,a') processes. 20 refs.; 4 figs.

21671 **(INS—566) Analysis of $\gamma$d -> $\pi$/sup 0/d in the energy region from 400 to 900 MeV.** (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study). Feb 1986. 11p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700933.

The differential cross section for $\gamma$d -> $\pi$/sup 0/d is estimated based on elementary processes. From a comparison between calculated results and experimental data in a backward region, it is found that the double scattering process becomes dominant and the effect of dibaryon resonances is not significant within the experimental accuracy.

21672 **(ITEF—38(1985)) Multiple rescattering in the intranuclear cascade model.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 23p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700969.

The following problems are considered in detail within the frames of the model of intranuclear cascade (MIC): number of interactions which a particle suffers in a nucleus (further on - multiplicty); different multiplicities contributing to particle production in kinematically forbidden region for particle scattering on a free nucleon; dependence of characteristics of interaction multiplicity on atomic weight of nucleus-target. pA reactions, where A is C or Pb nucleus, at kinetic energy of an incident proton T/sub 0/=8 GeV are considered. The conducted analysis confirmed expected qualitative characteristics of rescattering. Angular and energy distributions of interaction multiplicities can be explained wthin the frames of the model. Existence of high multiplicities both for a heavy Pb and light C nucleus turned to be unusual. 10 refs.; 15 figs.

21673 **(ITEF—144(1985)) Energy dependence of p-odd angular asymmetry for fragments and atomic nucleus fission dynamics.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 24p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700980.

Manifestation of sup(234)U and sup(240)Pu nucleus fission dynamics in the angular fragment asymmetry occuring due to parity violation in nucleon interaction is investigated. The fission motion is defined by the adiabatic equation with variable moment of inertia and the effective potential-fission barrier. Fission motion dissipation to internal one is taken into account by an introduction of absorption and consumption of energy of fission motion behind the fission barrier. Resonance state spectrum in the second well of fission barrier is obtained. It is found out that energy dependence of asymmetry is primarily defined by a relation of neutron resonance parameters and secondary by a dynamics of fission process through phase shift in a fission channel. Classification of types of angular asymmetry energy dependence is performed. Strong phase shift dependence on dissipation degree behind a barrier is discovered. Adjustment of experimental data by relations of the resonance theory of nuclear reactions with minimization of mean-square-root deviation leads to the conclusion on strong, but not total dissipation degree. 21 refs.; 10 figs.

21674 **(ITEP—60(1985)) Study on the mechanism of the /sup 3/He+p->p+p+d reaction at /sup 3/He momentum of 5 GeV/c.** Blinov, A.V.; Chuvilo, I.V.; Drobot, V.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 50p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700986.

The mechanism of the reaction /sup 3/He+p -> p+p+d is studied making use of the ITEP 80-cm liquid-hydrogen bubble chamber exposed to the beam of 5 GeV/c /sup 3/He nuclei. The reaction cross sections is equal to 20.6 +- 0.3 mb. The phase space regions associated with quasi-free scattering (QFS) and final state interaction (FSI) are selected. Angular, mass and momentum distributions of the reaction products are obtained in the entire kinematically allowed range. The experimental data in the QFS region are compared with theoretical calculations based on the simplest pole diagram approximation. The /sup 3/He and deuteron wave functions (WF) correspond to the realistic Reid potential. The D-wave components of these WF are taken into account. The absolute value of the cross section and shape of the distributions are described as a whole reasonably enough in the frame of the considered model in the kinematical region where FSI may be neglected. 34 refs.; 11 figs.; 3 tabs.

21675 **(LBL—22072) Introduction to quantum chromo transport theory for quark-gluon plasmas.** Gyulassy, M.; Elze, H.Th.; Iwazaki, A.; Vasak, D. (Lawrence Berkeley Lab., CA (USA)). Aug 1986. Contract AC03-76SF00098. 33p. (CONF-8606183—10; CONF-8606263—1). NTIS, PC A03/MF A01; GPO Dep. File Number DE87000937.

From NATO international advanced course on physics of strong fields; Maratea, Italy (1 Jun 1986).

Upcoming heavy ion experiments at the AGS and SPS are aimed at producing and diagnosing a primordial form of matter, the quark-gluon plasma. In these lectures some recent developments on formulating a quantum transport theory for quark-gluon plasmas are introduced. 46 refs.

21676 **(SLAC-PUB—3216) Future experiments on QCD effects in few nucleon systems with high energy electrons.** Arnold, R.G. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Sep 1983. Contract AC03-76SF00515. 10p. NTIS.

From 10. international conference on few body problems in physics; Karlsruhe, West Germany (22-27 Aug 1983).

A central question in the study of the few nucleon systems today is how to understand nuclear structure in terms of the quark degrees of freedom. It is now clear that nucleons are composite, and that QCD, the gauge theory of colored quarks and gluons, is probably the correct theory of hadronic matter. The question is: At what points in the authors description of nuclear structure do they have to abandon the conventional meson-nucleon theory in favor of quarks? In this talk some of the evidence for quarks in nuclei from previous high energy (E > 1 GeV) electron scattering experiments is reviewed. There is a great need for more electron data on nuclear targets. In response to that need there are now plans for more experiments in the near future.

21677 **Precompound decay in heavy ion reactions via the hybrid model.** Blann, M. (Physics Department, Lawrence Livermore National Laboratory, University of California, Livermore, California 94550). *Physical Review* [*Section*] *C: Nuclear Physics;* **35**: No. 4, 1581-1582(Apr 1987).

The hybrid model for precompound decay is applied to the calculation of neutron spectra following the /sup 20/Ne and /sup 12/C bombardment of /sup 165/Ho at 220, 292, (/sup 20/Ne), and 300 (/sup 12/C) MeV. Results are compared with experimentally deduced angle integrated spectra and with results of the Boltzmann master equation. Both models give excellent agreement with experimentally deduced spectra.

21678 **Superdeformed band in /sup 152/Dy as evidence for the centrifugal solidification of a rotating nucleus.** Swiatecki, W.J. (Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Physical Review Letters;* **58**: No. 12, 1184-1187(23 Mar 1987). Contract AC03-76SF00098.

The astonishing smoothness of the superdeformed rotational spectrum in /sup 152/Dy, from I = 22 to I = 60, is used as a basis for inferring a liquid-to-solid transition as the centrifugal force drives the nuclear shape into a closed-shell configuration.

21679 **Coupled-channels analysis of silicon-nickel fusion reactions.** Landowne, S.; Pieper, S.C.; Videbaek, F. (Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review* [*Section*] *C: Nuclear Physics;* **35**: No. 2, 597-604(Feb 1987). Contract W-31-109-ENG-38.

Coupled-channels calculations are carried out for the series of $^{28}$30Si+ $^{58,62,64}$Ni fusion reactions. The low-lying excitations of the projectile and target nuclei are taken into account within the rotational and vibrational models, respectively. The effects of one- and two-nucleon transfer reactions are included in the calculations using approximate methods. A good overall agreement with the data is obtained. The fusion cross sections apparently reflect changes in the radii of the nickel isotopes suggested by Hartree-Fock calculations.

21680 **Quark exchange in nuclei and the European Muon Collaboration effect.** Hoodbhoy, P.; Jaffe, R.L. (Physics Department, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 1, 113-121(1 Jan 1987).

Quark exchange between nucleons bound in a nucleus can cause a shift in the momentum distribution of quarks relative to free nucleons. This is true even if nucleon properties, including size, remain unchanged in the nuclear environment. This shift in momentum leads to a contribution to the matrix elements of single-quark operators which is nonadditive, and therefore cannot be incorporated into a convolution model. For A = 3 nuclei investigated here, such exchange contributions were found to be important, perhaps even dominant, in calculating the deviation from unity of the ratio of the nuclear structure function to that of the free nucleon (European Muon Collaboration ratio).

21681 **Formal framework for the electroproduction of polarized nucleons from nuclei.** Picklesimer, A.; Van Orden, J.W. (TRIUMF, Vancouver, British Columbia, Canada V6T 2A3 and Physics Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review* [*Section*] *C: Nuclear Physics;* **35**: No. 1, 266-279(Jan 1987).

A theoretical framework for the description of the (e-arrow-right,e'p-arrow-right) reaction is presented. A set of physically motivated, linearly independent four-vectors is employed to construct a complete set of second rank Lorentz tensors in terms of which the nuclear electromagnetic tensor is expressed. The implications of charge and parity conservation, time reversal, restricted spin dependence, and the final state boundary conditions are developed and applied. The azimuthal angular dependence (in the laboratory frame) of the nuclear tensor is made explicit, leading to the definition of a set of 18 independent response functions. The cross section and the polarization vector of the ejected proton are expressed in terms of the 13 new, spin-dependent response functions. The physical significance of these response functions with regard to spin observables is manifest. The separation of the response functions, both theoretically and experimentally, is discussed. Extensions and restrictions to the general (e-arrow-right,e'X) reaction, to reactions which violate current and/or parity conservation, and to the case of oriented (polarized) targets are evident. Questions of linear dependence, completeness, and alternative representations of the nuclear tensor for both (e-arrow-right,e'p-arrow-right) and the general (e-arrow-right,e'X) reaction are resolved. Preliminary numerical results indicate the sizes and relative importances of the new response functions and demonstrate their experimental accessibility.

21682 **Need for new physics in statistical models of nuclear de-excitation.** La Rana, G.; Moses, D.J.; Parker, W.E.; Kaplan, M.; Logan, D.; Lacey, R.; Alexander, J.M.; Welberry, R.J. (Department of Chemistry, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Physical Review* [*Section*] *C: Nuclear Physics;* **35**: No. 1, 373-376(Jan 1987).

We have measured energy spectra and angular distributions of $^{1}$H and $^{4}$He from 190—MeV /sup 40/Ar+ /sup 27/Al reactions. Comparisons with statistical model calculations show that evaporation from spherical nuclei cannot account for both the energy spectra and angular distributions, using entrance channel spins and evaporation barriers derived from fusion data. Alterations are required in both the emission barriers and the moments of inertia. Extensive nuclear deformation could explain the $^{4}$He data but discrepancies remain with the $^{1}$H spectra, suggesting that additional effects are needed in the models.

21683 **Heavy-ion resonances.** Erb, K.A.; Bromley, D.A. (Oak Ridge National Lab., TN). pp 201-310 of Treatise on heavy-ion science. Vol. 3. Bromley, D.A. (ed.). New York, NY; Plenum Publishing Corp. (1985). Contract W-7405-ENG-26.

The objective is to survey what has been learned from the enormous effort of the last two decades and to identify promising areas for further investigation. The discussion is organized partly along the lines suggested by the different types of energy-dependent structure observed. Section 2 deals with the sharp resonances observed at low energies, particularly in collisions of $^{12}$C + $^{12}$C and $^{12}$C + $^{16}$O nuclei. Section 3 discusses gross structure in quasielastic reactions, typified by the broad bumps with widths and spacings of some 4 to 5 MeV, and then considers its fragmentation into the narrow resonances evident in the figure. Section 3 concludes with a discussion of the qualitatively different, very broad structure seen at the highest energies. Those resonances that appear primarily in extreme forward or backward angle data are treated separately in Section 4. Section 5 deals with energy-dependent structure in fusion yields, while resonances in systems with A $\geqq$ 40 are discussed in Section 6.

21684 **Transuranium nuclei.** Seaborg, G.T.; Loveland, W.D. (Lawrence Berkeley Lab., CA). pp 255-330 of Treatise on heavy-ion science. Vol. 4. Bromley, D.A. (ed.). New York, NY; Plenum Publishing Corporation (1985). Contract AC03-76SF00098;AT06-78ER70035.

In this chapter from Treatise on Heavy-Ion Science, volume 4, the authors review the state of knowledge of transuranium elements. The history of the discovery of the transuranium elements is outlined. The nuclear and chemical properties of these elements are presented and techniques for identifying them as products of heavy ion reactions are discussed. Different techniques for producing transuranium elements are presented. The chapter concludes with a discussion of future directions for research in this field.

21685 **Spin flip excitations in light nuclei.** Castel, B.; Van Hees, A.G.; Sagawa, H.; Zamick, L. (Oak Ridge National Lab., Oak Ridge, TN 37830). pp 458-463 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

The authors present a shell model analysis of electric spin excitations taking /sup 16/O as an example. They also discuss more generally the experimental and theoretical situation as it relates to

electric spin resonances and their coexistence with other S=O states.

21686 **Baryon-baryon interaction from quark model viewpoint.** Oka, M.; Yazaki, K. (Center for Theoretical Physics, Lab. for Nuclear Science and Dept. of Physics, Massachusetts Institute of Technology, Cambridge, MA 02139). pp 489-567 of Quarks and nuclei. Weise, W. Philadelphia, PA; World Scientific Pub. Co. (1984).

The study of the baryon-baryon interaction based on the non-relativistic quark cluster model is reviewed. The structure of the wave functions for three- and six-quark systems and the description in terms of the resonating group method (RGM) are studied. The Hamiltonian for the multi-quark system is discussed in connection with the problem of the space truncation and the color van der Waals force. The results of applications to nucleon-nucleon, nucleon-hyperon and hyperon-hyperon systems are summarized. The state dependence of the short-range repulsion and its origin are examined. The comparison with the bag model is briefly discussed. A realistic model of the nuclear force is constructed and its off-shell property is examined. The quark model version of the di-hyperon state is also discussed.

21687 **Nuclear tests of Lepton number and CP nonconservation.** Haxton, W.C. (Institute for Nuclear Theory, Univ. of Washington, Seattle, WA 98195). pp 471-487 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

The author discusses two topics, double beta decay and time-reversal-odd nuclear moments, in which questions of nuclear structure are addressed. These problems are taken from a growing class of nuclear and atomic experiments in which the special properties of many-body systems are exploited to test properties of elementary particles. Nuclei can serve as filters for interactions by providing kinematic "windows" where only certain processes can occur and by isolating quantum numbers such as spin, isospin, and parity.

21688 **Some high spin states shell model studies in the 88 ≦A≦ 100 region.** Amusa, A. (Physics Div., Argonne National Lab., Argonne, IL). pp 596-609 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

The results of shell model calculations for the states of /sup 95/Rh, /sup 94/Ru, /sup 91/Tc, /sup 89/Nb and /sup 87/Y using a (2rho/sub 1/2/1g/sub 9/2/)/sup eta/ model space and N=50, Z=38 shell closures are presented. Apart from the case of /sup 87/Y, the results support the observed excitation energies and decay modes in each nucleus. Extra model space mixing is invoked for the structures of yrast and yrare 25/2/sup -/ and 29/2/sup -/ states in /sup 91/Tc, and the 19/2/sup -/ state in /sup 89/Nb in order to explain experiment and also to explain the absence of seniority isomers in /sup 94/Ru and /sup 95/Rh.

21689 **New symmetry regions in the IBA and a simplified approach to nuclear phase transitions.** Casten, R.F. (Brookhaven National Lab., Upton, NY 11973). pp 90-122 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

The IBA treatment of nuclear symmetries and transition regions is discussed. A new, extensive region of 0(6) nuclei near A=130 is presented and compared with the Pt isotopes. Nearly identical level schemes characterize both regions, including similar relations between the 0(6) and 0(5) steps in the dynamical symmetry chain decomposition, and similar discrepancies with the 0(6) limit. Simple calculations that incorporate a triaxial component as an 0(6) symmetry breaking mechanism remove these discrepancies in both regions.

21690 **Extension of the consistent Q Formalism to odd-A nuclei in the W-Pt region.** Warner, D.D.; Van Isacker, P.; Jolie, J.; Bruce, A.M. (Brookhaven National Lab., Upton, NY 11973). pp 156-169 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

It is shown that the approach of the Consistent Q Formalism, which has proved successful in the Interacting Boson Model description of even-even nuclei, can be extended to odd A nuclei within the framework of the Interacting Boson-Fermion Model. The proposed method describes the transition between the SU(3) and O(6) symmetry limits of the U(6/12) boson fermion group, and can be applied to the odd neutron W, Os, Pt nuclei. As in the even-even case, a number of parameter-free predictions emerge for the transitional region concerning energies, B(E2) values and also single particle structure factors, and some of these are compared to existing data for the odd Os nuclei.

21691 **Low-lying isovector excitations in heavy nuclei.** Ginocchio, J.N. (Theoretical Div., Los Alamos National Lab., Los Alamos, NM 87545). pp 220-233 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

The neutron-neutron and proton-proton effective interaction in nuclei is qualitatively different than the neutron-proton effective interaction in nuclei. This difference can lead to low-lying isovector J/sup $\pi$/=2/sup +/ states in heavy nuclei. This paper explores the consequences of this effective nucleon-nucleon interaction for producing low-lying isovector neutron-proton excitations in nuclei. These excitations are studied using the Neutron-Proton Interacting Boson Model (IBM-2) which treats the neutron-proton degrees of freedom explicitly.

21692 **Methods for deriving nuclear single particle potentials.** Kuo, T.T.S. (Dept. of Physics, State Univ. of New York at Stony Brook, Stony Brook, NY 11794). pp 315-330 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

In treating nuclear many-body problems Hpsi = Epsi with H = T + V/sub NN/, an important step is to introduce a single-particle (s.p.) potential U and rewrite H as H/sub 0/+H/sub 1/ with H/sub 0/ = T+U and H/sub 1/ = V/sub NN/-U. An example is the nuclear shell model which may be considered as a choice of U = 1/2 m$\omega$/sup 2/r/sup 2/ and the belief that this U should "minimize" H/sub 1/ so that it can be replaced by some residual effective interaction. The authors discusses two methods for defining and deriving U: a model-space Hartree-Fock approach and a Green's function effective mass operator approach. The connection between these two approaches is discussed. Applications of the model-space Hartree-Fock U to nuclear matter calculations using Paris and Reif nucleon-nucleon potentials have led to encouraging results. Comparing with the conventional lowest order BHF calculations of nuclear matter, our present calculations give an additional binding energy of — 4 MeV per nucleon. Possibilities of using these approaches to the study of nuclear shell-model s.p. potentials are discussed.

21693 **g-factor measurements on excited states.** Hill, J.C.; Wohn, F.K.; Wolf, A.; Berant, Z.; Gill, R.L.; Mach, H.; Rafailovich, M.; Kruse, H.; Wildenthal, B.H.; Peaslee, G. (Ames Lab. USDOE, Iowa State Univ., Ames, IA 50011). pp 398-409 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

A program for the measurement of g-factors for excited states of neutron-rich nuclei at the TRISTAN separator facility is described. The authors determine effective proton spin and orbital g-factors of two odd-Z nuclei and are able to reproduce observed g-factors for five even-even nuclei.

21694 **Microscopic analysis of angular momentum projected HFB-states in terms of interacting bosons.** Ring, P.; Pannert, W. (Nuclear Science Div., Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). pp 426-434 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—). Contract AC03-76SF00098.

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

Angular momentum- and number-projected Hartree-Fock-Bogoliubov (HFB) wavefunctions for transitional and deformed Rare Earth nuclei are analyzed in terms of Fermion pairs coupled to angular momenta L = 0(S), 2(D), 4(G), etc. The Fermion space is truncated to contain only S-D for S-D-G pairs. The variation is carried out before and after angular momentum projection and with different truncations. The influence of the truncation on physical quantities such as moments of inertia, quadrupole moments or pair-transfer matrix elements is discussed.

21695 **Occurrence of intruder states at single and double subshell closure.** Meyer, R.A.; Henry, E.A.; Molnar, G.; Yates, S.W.; Sistemich, K. (Lawrence Livermore National Lab., Livermore, CA 94550). pp 435-446 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

Evidence is presented in support of coexisting structures near and at single and double SUBshell closure.

21696 **Shell-model Lanczos-method studies of the Gamow-Teller strength function in astrophysics.** Mathews, G.J.; Bloom, S.D.; Takahashi, K.; Fuller, G.M.; Hausman, R.F. (Lawrence Livermore National Lab., Livermore, CA 94550). pp 447-457 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

The authors utilize the Livermore system of vectorized shell-model codes to study the Gamow-Teller strength functions for a variety of nuclei whose weak-interaction properties are of interest in astrophysics. The Lanczos method is used to diagonalize a model space consisting of low-seniority excitations (including all states directly populated by the Gamow-Teller operator) with a realistic finite-range effective interaction. The effects of model-space truncation are systematically investigated for each nucleus. The results of these calculations are discussed in connection with problems in stellar evolution, supernova collapse, and nucleosynthesis.

21697 **Consistency and A-dependence of empirical effective interactions.** Daehnick, W.W. (Nuclear Physics Lab., Univ. of Pittsburgh, Pittsburgh, PA 15260). pp 645-649 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

Many shell model interaction matrix elements for configuration spaces as large as a complete major shell can be measured directly with transfer reactions. Some earlier, seemingly contradictory data in the A=90 region have been re-investigated. The results show that the use of centroid energies, i.e. the measurement and inclusion of the weaker fractions of the spectroscopic strengths, is required for the extraction of more generally valid matrix elements.

21698 **Projected Hartree-Fock calculations in the (SD) shell using realistic effective interactions.** Osnes, E.; Brut, F. (Dept. of Physics, State Univ. of New York at Stony Brook, Stony Brook, NY 11794). pp 711-727 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

The authors have performed projected Hartree-Fock calculations of the positive parity states in the A = 21 nuclei using three different realistic effective interactions. One of these was evaluated in the so-called screened Tamm-Dancoff approximation using the Hamada-Johnston potential while the other two were evaluated from the Bonn-Julich and Paris potentials including essentially all important long-range correlations to all orders. The resulting energy spectra show reasonable agreement with the experimental spectra and compare favorably with the results obtained using the Kuo-Brown and Preedom-Wildenthal interactions. Further, the calculation approximately reproduces the results of particle-rotor model calculations and thus accounts for the rotational features of these nuclei.

21699 **Continuum shell model calculations and the resonances below the GDR in /sup 12/C.** Ramavataram, S. (Dept. of Nuclear Energy, National Nuclear Data Center, Brookhaven National Lab., Upton, NY 11973). pp 728-736 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—).

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

It is shown that definitive spin, and parity assignments can be made for several dominant resonances reported in literature. Comparison with recent (e,e') data analysis not only confirms the authors' model predictions but also demonstrates that level energies are well reproduced within the multiconfigurational shell model only if continuum effects are included.

21700 **Estimate of p + d → $^3$He → γ contribution to the radiative capture reaction p + d → $^3$He + γ at T/sub p/ = 450 MeV.** Prats, F.; Briscoe, W.J. (George Washington Univ., Washington, DC). pp 283-284 of Few body problems in physics. Vol.II. Zeitnitz, B. (ed.). New York, NY; Elsevier Science Publishers B.V. (1984).

The contribution of the process p + d → $^3$He + γγ for the kinematical conditions of the p-d radiative capture coincidence measurements of B.H. Silverman et al. (T/sub p/ = 450 MeV and theta(c.m.) = 60° and 90°) has been calculated assuming that the two photon emission is due to virtual $\pi^0$ production. Measured angular distributions for pd→He$\pi^0$ at kinematical conditions were used for a reliable estimate of absolute value $T^2$. It is found that the two photon contribution is at least five orders of magnitude smaller than the single photon radiative capture and, thus, cannot contribute significantly to the yield measured in that experiment.

21701 **Methods of fluid dynamics in nuclear physics.** Zweifel, P.F. (Virginia Polytechnic Institute and State Univ., Blacksburg). *Transport Theory and Statistical Physics;* 13: No. 5, 649-661(1984). Contract AS05-80ER10711.

From Methods of fluid dynamics in nuclear physics; Catania, Italy (9-11 Apr 1984).

The author summaries the contributions to an interdisciplinary workshop attended by physicist and mathematicians at the University of Catania in Italy. The purpose of the workshop was to bring together physicists and mathematicians with an interest in fluid mechanical calculations. Several applications to nuclear structure and heavy ion collisions are outlined.

21702 **Dynamics.** Moniz, E.J. (Massachusetts Institute of Technology, Cambridge). pp 251-283 of Symmetries in nuclear structure. Abrahams, K.; Allaart, K.; Dieperink, A.E.L. (eds.). New York, NY; Plenum Publishing Corporation (1983). Contract AC02-76ER03069.

These lectures discuss the properties and interactions with nuclei of Δ's. To do so, the authors must establish first a common idea about what a Δ is. This will be the topic of discussion in Chapter II, wherein an isobar model is developed which allows us to discuss precisely the propagation and dynamics of the Δ as an unstable particle. In Chapter III, the extraction of Δ-nucleus interaction parameters from an analysis of intermediate energy pion- and photon-initiated nuclear reactions is discussed. The central result is the strength of the Δ-nucleus optical potential, which is found to have a large imaginary part associated with intermediate coupling to purely nuclear states (i.e., pion annihilation channels). The isospin signature provided by the pion annihilation dynamics both lends support to this interpretation and leads to new predictions for inelastic pion reactions. Finally, in Chapter IV the role of Δ's in low energy nuclear properties is described. This subject has received considerable attention because of the special role played by the Δ in nuclear spin-isospin excitations (the Δ is a static spin-flip nucleon excitation in the quark model). Focus will be on the ambiguities inherent in such discussions both because of the dynamical nature of the resonance discussed in Chapter II and because the quarks are the true nucleon internal degrees of freedom.

21703 **Polarization of nucleons elastically scattered from nuclei.** Snow, G.A.; Sternheimer, R.M.; Yang, C.N. (Brookhaven National Lab., Upton, NY). pp 169-170 of Selected papers 1945-1980 - with commentary. Chen Ning Yang. San Francisco, CA; W.H. Freeman and Company (1983).

Reprinted from Physical Review; 94: No.4, 1073-1074(15 May 1954).

Several recent experiments have shown that protons of energy 200-350 Mev scattered from nuclei are polarized. The elastically scattered proton have a polarization (~ 60%) that is somewhat larger than the inelastically scattered ones. Fermi has proposed an explanation of the polarization for elastic scattering in terms of a nuclear spin-orbit interaction potential similar to that assumed in the nuclear shell model. The authors used the Born approximation in their estimates. The purpose of this note is to investigate the polarization effects of a nuclear spin-orbit potential using the transparent nuclear model of Serber.

## 6540 Radiation And Shielding Physics

*REFER ALSO TO CITATION(S) 20726, 21640, 21803*

21704 **(CONF-861102—40) Monte Carlo-narrow resonance calculational techniques for treating double-heterogeneity effects.** Gelbard, E.M.; Chen, I.J. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004747.

From American Nuclear Society and Atomic Industrial Forum joint meeting; Washington, DC, USA (16 Nov 1986).

Reliable methods already exist for computing resonance integrals (RI's) in regular lattices. But lattice structures always contain irregularities. Such effects have been called "double-heterogeneity" effects. Two methods for computing double heterogeneity effects on RI's are reviewed and evaluated. 2 refs., 1 tab.

21705 **(FEI—1739) Interaction of slow neutrons with water in near- and subcritical region. Analysis of translational part of scattering law.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1985. 20p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700871.

From the experimental scattering law (SL) of slow neutrons with water being in post-critical state (t=400 deg C) separated is its translational part (SLTP) that is analysed on the basis of two-phase model and is used to extract information on triple correlations in water and to compare with forecasts of generalized kinetic theory. A possibility is shown to describe the slow neutron scattering cross section with subcritical water of the two-phase model; relative concentrations of liquid and gas phases found proceeding from this description agree satisfactorily with those obtained before. Isothermal pressure derivative from SLTP is obtained. A comparison of natural experimental semiwidth of SLTP with forecasts of generalized kinetic theory has shown that even at post-critical temperatures and moderated densities translational motion of water steam molecules can not be described by the solid sphere model, but demonstrates effects connected with the influence of intermolecular attraction forces. 20 refs.; 6 figs.

21706 **(HMI—394) HMI Department of Nuclear Chemistry and Reactor. Scientific report 1982.** (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.). Bereich Kernchemie und Reaktor). 1983. 157p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87751282.

This report depicts in brief the essential issues of R and D work carried out within the various departments of the Institute in 1982. Such are: in the field of 'neutron scatter': observation of critical phenomena with incoherent neutron scatter; in the field of 'radiation damage to solids': irradiation-induced diffusion, nucleation and dissociation in metals and alloys; in the field of 'reactor chemistry': radiation effects in selected crystalline phases of solidificated high-activity wastes; in the field of 'trace elements in bio-medicine': investigation of the biological function of selenium with respect to reproduction as values work on paraplacental exchange of Cd and Pb during pregnancy; in the field of 'geochemistry': investigation of aqueous geochemical systems under hydrothermal pressure and temperature conditions; in the field of 'reactor operation': periods of shutdown owing to faulty operation, expansion planning, utilization for irradiation experiments. The report also includes comprehensive lists of publications and lectures.

21707 **(HMI-B—419) HMI Department of Nuclear Chemistry and Reactor. Scientific report 1984.** (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.). Bereich Kernchemie und Reaktor). 1985. 163p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87751283.

The report gives an account of ongoing R and D work in the following fields: 1) Neutron scattering (method development, crystallography); 2) Damage to solids due to radiation (i.a. reactions to failure, atom transport, changes in material properties); 3) Reactor chemistry (solidification products far radioactive wastes; gas/graphite reactions within the first wall of a fusion reactor); 4) Biomedical trace element research (transport and storage of bioelements, trace element analytics); 5) Geochemical reservoir exploration technique (distribution of elements, complexing etc.); 6) Reactor operation, utilization and possible extensions. Furthermore, a survey is given on publications and lectures as well as on correlations with other fields of research.

21708 (INIS-mf—10565, pp 50-52) **Total cross sections of ultracold neutron interaction with lead and quartz glass.** Antonov, A.V.; Isakov, A.I.; Kuznetsov, S.P.; Meshkov, I.V.; Perekrestenko, A.D. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780085.

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In Experimental and theoretical physics. Collection.

Total cross sections of ultracold neutron interaction with Pb and quartz glass are investigated at 293 and 160 K temperatures using the ultracold neutron spectrometer.

21709 **(SAND—86-2300C) ITS: The integrated tiger series of coupled electron/photon Monte Carlo transport codes.** Halbleib, J.A.; Mehlhorn, T.A. (Sandia National Labs., Albuquerque, NM (USA)). 17 Nov 1986. Contract AC04-76DP00789. 4p. (CONF-8611115—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87003504.

From Nuclear explosives code development conference; Albuquerque, NM, USA (17 Nov 1986).

ITS is a powerful and user-friendly software package permitting state-of-the-art Monte Carlo solution of linear time-integrated coupled electron/photon radiation transport problems, with or without the presence of macroscopic electric and magnetic fields of arbitrary spatial dependence. Our goal has been to simultaneously maximize operational simplicity and physical accuracy. Through a machine portable utility that emulates the basic features of the CDC UPDATE processor, the user selects one of eight codes for running on a machine of one of four (at least) major vendors. The ease with which this utility is applied combines with an input

scheme based on order-independent descriptive keywords that makes maximum use of defaults and internal error checking to provide experimentalists and theorists alike with a method for the routine but rigorous solution of sophisticated radiation transport problems. Physical rigor is maximized by employing the best available cross sections and sampling distributions, and the most complete physical model for describing the production and transport of the electron/photon cascade from 1.0 GeV down to 1.0 keV. Flexibility of construction permits the more sophisticated user to tailor the codes to specific applications and to extend the capabilities of the codes to more complex applications through simple update procedures.

21710 **Electronic polarization induced in solids traversed by fast ions.** Gemmell, D.S.; Vager, Z. (Argonne National Lab., IL). pp 243-284 of Treatise on heavy-ion science. Vol 6. Bromely, D.A. (ed.). New York, NY; Plenum Publishing Corporation (1985). Contract W-31-109-ENG-38.

In this chapter from Treatise on Heavy-Ion Science, Volume 6, the response of the electrons in a solid target to the passage of a fast positively charged ionic projectile is discussed. Fast, in this context, means projectile velocities, v, large compared with the Fermi velocities of the target electrons, but not so large that a relativistic treatment is required. That is, $v_0 << v << c$, where $v_0$ is a Bohr velocity, $e^2/h$. This corresponds to projectile energies lying in the range roughly between 0.1 and 10.0 MeV/nucleon. The restriction here to nonrelativistic velocities is just for convenience; in general the extension of the discussion to relativistic projectile velocities is straightforward. The primary concern is the polarization wake that is induced in a solid during its traversal by a fast ion. Theoretical models for the wake are renewed and some recent experiments with molecular-ion beams are described.

21711 **Completeness theorems in transport theory.** Zweifel, P.F. (Virginia Polytechnic Institute and State Univ., Blacksburg). *Transport Theory and Statistical Physics;* **13**: No. 1-2, 57-67(1984). Contract AS05-80ER10711.

Ever since K. M.; Case's famous 1960 paper, transport theorists have been studying the questions of full- and half-range completeness for various transport type equations. The purpose of this note is to try to define exactly what is meant by completeness as it is needed, and used, in solving transport equations and to discuss some of the various techniques which have been, or might be, used to verify completeness. Attention is restricted to the question of full-range completeness. As a paradigm the generalized form of the transport equation first introduced by Beals is adopted.

## 6550 Medical Physics

*REFER ALSO TO CITATION(S) 21163, 21203*

21712 (IA—1421, pp 168) **Influence of nonuniform spatial distribution on lung counting.** Talmor, A.; Laichter, Y.; Ben-Haim, Y.; Kushilevsky, A. (Israel Atomic Energy Commission, Tel Aviv; Technion-Israel Inst. of Tech., Haifa; Ben-Gurion Univ. of the Negev, Beersheba, Israel). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21713 (IA—1421, pp 174-175) **Occupational exposure to ionizing radiation in Israel in the year 1984.** Malchi, S.; Shamai, Y.; Israeli, M.; Schlesinger, T. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21714 (INIS-BR—568) **Estimation of effective dose equivalents from external irradiations.** (Minas Gerais Univ., Belo Horizonte (Brazil)). Jul 1985. 96p. (In Portuguese). NTIS (US Sales Only), PC A05/MF A01. File Number DE87700916.

A methodology for computing effective dose equivalent, derived from the computer code ALGAM: Monte Carlo Estimation of Internal Dose from Gamma-ray Sources in a Phantom Man, developed at Oak Ridge National Laboratory, is presented. The modified code was run for 12 different photon energy levels, from 0.010 Mev to 4.0 Mev, which provides computing the absorved dose, for these energy levels, in each one of the 97 organs of the original code. The code also was run for the principal energy levels used in the calibration of the dosimetric films. The results of the absorved doses per photon obtained for these levels of energy have been transformed in effective dose equivalents. (M.A.C.).

21715 (INIS-mf—10570, pp 97-109) **Assessment of nuclear power sources in Czechoslovakia with respect to radiation protection limits.** Melichar, Z. (Vyskumny Ustav Energeticky, Jaslovske Bohunice, Czechoslovakia). 1985. (In Slovak). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701462. (CONF-8505340—Exc.).

From Prediction of environmental impact of power generation conference; Bratislava, Czechoslovakia (23 May 1985).

The principles are presented which underlie the determination of limits of planned population exposure during normal operation of nuclear installations and of reference levels of exceptional population exposure during nuclear power plant accidents. The introduction is discussed of authorized limits and levels in Czechoslovakia the USSR, CMEA countries and Sweden. An estimate is made of the radiation burden of the population during the development of the Czechoslovak nuclear power programme. (E.S.).

21716 **(PPA-C—7.1) Manual on theory and practical aspects of bioassay.** (Unit Tenaga Nuklear, Bangi, Selangor (Malaysia)). Jun 1985. 77p. (In Malay). Nuclear Energy Unit, Kompleks PUSPATI, 43000 Kajang (MY).

This manual is set to provide necessary basic guidance on theory and practical aspects of bioassay specially for the newcomer in this field and the man in the laboratory. The first part is a brief information on the entry of radionuclides into the body, the metabolism and the programs of bioassay. All other factors to be considered in assessing internal contamination in man have also been brought up. In the second part, various procedures of radiochemical separations, detection and measurements are abstracted from journals and other revisions. Some methods have been attempted and to be followed where appropriate.

## 6560 Condensed Matter Physics

*REFER ALSO TO CITATION(S) 20555, 20559, 20563, 20567, 20574, 20601, 20607, 20609, 20621, 20622, 20654, 20712, 21803, 21942*

21717 **(AD-A—175560/2/XAB) Nondestructive evaluation of dislocations in iron single crystals by positron annihilation.** Park, Y.K.; Waber, J.T. (Northwestern Univ., Evanston, IL (USA)). Jul 1986. 8p. NTIS, PC A02/MF A01.

Published in Proceedings of APCS, 353-358(3-5 Jul 1986).

A new nondestructive method for determining dislocation density was introduced. The positron lifetime spectrum was analyzed to separate the screw- and edge-dislocation components in pure iron single crystals. The dislocation density measured by the positron annihilation technique was compared with the result of transmission electron microscopy (TEM). Recovery stages in pure iron single crystals were studied using positron-annihilation Doppler broadening.

21718 **(AD-A—175601/4/XAB) Dislocation studies on deformed single crystals of high-purity iron using positron annihilation: determination of dislocation densities.** Park, Y.; Waber, J.T.; Meshii, M.; Snead, C.L.; Park, C.G. (Northwestern Univ., Evanston, IL (USA). Dept. of Materials Science and Engineering). 15 Jul 1986. 15p. NTIS, PC A02/MF A01.

Published in Physical Review B, Vol. 34, No. 2 823-836(15 Jul 1986).

A new method for determining the total number of dislocations per unit area, as well as the fraction of screw and edge components, is presented. Single-crystal specimens that have been a) bent over a mandrel, b) cold rolled at room temperature, and c) deformed in tension at 200 K were studied. Etch pits were studied in

connection with this work and were found to be primarily of the (111) type. The density of emergent dislocations as determined by the etch pits was found to be smaller than the number determined by the positron-annihilation technique.

21719 **(CONF-8609252—1) Charge exchange processes between highly charged ions and metal surfaces.** Meyer, F.W.; Havener, C.C.; Overbury, S.H.; Snowdon, K.J.; Zehner, D.M.; Heiland, W.; Hemme, H. (Oak Ridge National Lab., TN (USA); Osnabrueck Univ. (Germany, F.R.)). 17 Sep 1986. Contract AC05-84OR21400. 17p. NTIS MF A01; 2; GPO Dep. File Number DE87005778.

From Conference on the physics of multiple charged ions; Groningen, Netherlands (17 Sep 1986).

The interaction of highly charged ions (argon, nitrogen, and oxygen) with metal surfaces (gold single crystal) causes the emission of electrons. Energy spectra of the emitted electrons reveal, for sufficiently high charge states of the projectile, the occurrence of Auger deexcitation of projectile inner shell vacancies brought into the interaction as well as inter-atomic charge exchange leading to the emission of target Auger electrons. 25 refs., 5 figs.

21720 **(DOE/ER/53167—1) Cesium ion bombardment of metal surfaces: Final report for period January 1984 to May 1986.** Seidl, M.; Carr, W.; Tompa, G.S. (Stevens Inst. of Tech., Hoboken, NJ (USA)). May 1986. Contract AC02-84ER53167. 130p. NTIS MF A01; 2; GPO Dep. File Number DE87005704.

The steady state Cs coverage due to $Cs^+$ bombardment of polycrystalline Mo and W has been studied for the incident energy range below 500 eV. When a sample is exposed to a $Cs^+$ ion beam, the work function decreases until steady state is reached with a total dose of less than $\simeq 1*10^{16}$ ions/cm$^2$, for both W and Mo. A steady state minimum work function surface is produced at an incident energy of $\simeq$100 eV for Mo and at an incident energy of $\simeq$45 eV for W. At a given bombarding energy the Cs coverage of W is uniformly less than that of Mo. H coadsorption does not have a large effect on the steady state work function. A theory describing the steady state coverage has been developed and is used to make predictions for other materials. 94 refs., 37 figs.

21721 **(EFI—746(61)-84) Radiation energy losses of relativistic electrons and positrons at plane channeling and quasichanneling.** (Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike, Moscow (USSR)). 1984. 20p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700859.

A model potential of continuous crystallographic planes, very close to the Moliere-Appleton potential, but allowing analytical solution of equation of motion is introduced. Total radiation energy loss of relativistic electrons and positrons at plane channeling and quasichanneling in a diamond single crystal is calculated for particle trajectories by means of the expressions obtained. Angular distributions of radiation loss as a function of the particle entrance angle into the crystal are investigated. 8 refs.; 6 figs.

21722 **(FEI—1627) Mechanisms of interstitial loop formation in metals under low radiation doses.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1984. 19p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700865.

The process of interstitial loop formation in metals at the initial period of radiation is theoretically investigated. Comparison of the obtained analytical estimations of limiting loop concentration with experimental data permits to obtain such characteristics of point defects as migration energy of host interstitial (HI), binding energy of two HI as well as migration and binding energies of the complex HI-atom impurity. Experimental data on concentration of interstitial loops in Ni, Fe and Au at low radiation doses are discussed. 18 refs.; 7 figs.

21723 (IA—1421, pp 7) **Diffraction spectrum of a general family of linear quasiperiodic arrays.** Aviram, I. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21724 (IA—1421, pp 14-15) **Reacting turbulent flow produced by two concentric tubes of finite wall thickness.** Geyer, I.; Bar-Ziv, E.; Apelblat, A. (Israel Atomic Energy Commission, Tel Aviv; Ben-Gurion Univ. of the Negev, Beersheba, Israel). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21725 (IA—1421, pp 63) **ESR studies in semiconductor-insulator two-layer structures.** Suss, J.T.; Zemel, A.; Rotter, S.; Zevin, V. (Israel Atomic Energy Commission, Tel Aviv; Hebrew Univ., Jerusalem, Israel). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21726 (IA—1421, pp 69-70) **Neutron diffraction study of HNO/sub 3/-GIC low temperature structure.** Shaked, H.; Melamud, M.; Pinto, H.; Hitterman, R.; Faber, J. (Israel Atomic Energy Commission, Tel Aviv; Argonne National Lab., IL, USA). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21727 (IA—1421, pp 111) **Three-detector system for perturbed angular correlations.** Berant, Z.; Wolf, A. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21728 (IA—1421, pp 13-14) **Electromagnetic field interaction with fast-moving dipoles.** Strauss, M.; Oreg, J.; Kurizki, G.; Ben-Reuven, A. (Israel Atomic Energy Commission, Tel Aviv; Weizmann Inst. of Science, Rehovoth, Israel). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21729 (IA—1421, pp 72) **Valence band plasmon effects on line shifts and widths in positron planar channeling radiation.** Strauss, M.; Amendt, P.; Rahman, H.V.; Rostoker, N. (Israel Atomic Energy Commission, Tel Aviv; New York Univ., NY, USA). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21730 (IA—1421, pp 103) **Influence of nitrogen pre-implantation on the properties of He implanted materials.** Lifshitz, Y.; Shamash, S.; Cheifetz, E. (Israel Atomic Energy Commission, Tel Aviv; Weizmann Inst. of Science, Rehovoth, Israel). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21731 (IA—1421, pp 113) **Influence of the giant dipole resonance structure on elastic gamma-ray scattering from / sup 209/Bi.** Kahane, S. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21732 **(IAE—3954/2) Nuclear magnetic gamma double resonance.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 52p. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87700874.

A number of problems corresponding to different variants of experiments using nuclear magnetic-gamma double resonance (NMGDR) are theoretically investigated. Calculation is carried out and its results are compared to experimental ones concerning NMGDR for tantalum. Time dynamics of the source or scatterer nucleus sublevel populations under double resonance conditions with non-uniform initial population of this nucleus sublevels is studied. 10 refs.; 22 figs.

21733 **(IAE—4073/9) By layer analysis of structural perfection of monocrystal near surface layers by the asymptotic Bragg diffraction.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1985. 16p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700879.

Using three-crystal X-ray diffractometry angular dependences of intensity of pure diffractive X-ray scattering I(THETA) in Ge and Si monocrystals (with a natural oxide film on the surface) are investigated with the angles of crystal turn from the position of Bragg peak exceeding more than 500 times its half-width. I(THETA) dependence at such large angles of turn (ΔTHETA) possesses information on the change of statistical and dynamical Debye-Waller factors along the crystal depth with the resolution order of 1 nm. In the theory when condidering diffraction averaged according to large number of planes scattering characteristics are used due to weak interaction of X-rays with the crystal. Because of high resolution in the method of asymptotic Bragg diffraction the necessity of by-layer accounting for the variation of scattering characteristics (Debye-Waller factor) and for interplane distance occurred for the first time. General theoretical analysis of the problem is presented. Debye-Waller factors on the crystal-oxide film barrier are restored. 7 refs.; 7 figs.; 1 tab.

21734 **(IAE—4084/11) Sputtering by nuclear fragments.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1985. 24p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700880.

Theory of monocrystal and polycrystal metal sputtering by nucleus fission fragments is constructed. The target material destruction occurs at the expense of energy; released in the electronic subsystem. The process of hot electron area formation around the fragment trajectory and the mechanism of hot electron energy transfer to the central atoms at the polycrystal grain boundary and at the metal-vacuum boundary are considered. The monocrystal sputtering coefficient constitutes approximately 50; the maximum sputtering coefficient for the fine-grained polycrystals constitutes approximately 10/sup 5/ at/fr. 12 refs.; 3 figs.; 4 tabs.

21735 **(IAE—4128/9) Reconstruction of parahydrogen phonon density from neutron data. Multiphonon process consideration.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1985. 19p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701398.

An iterative method for calculation of a phonon density function g(epsilon) of solid parahydrogen according to data on in elastic non-coherent scattering of low-velocity neutrons under conditions of a considerable contribution of multiphonon processes is described. For polycrystals at T=12 K and p=30 bar the function g(epsilon) and the series of its integral characteristics are obtained. Analysis of the results points to essential effect of anharmonism of zero oscillations of g(epsilon). 5 figs.

21736 **(IC—86/21) Skin friction on the unsteady free convection flow past an accelerated vertical porous plate.** (International Centre for Theoretical Physics, Trieste (Italy)). Jan 1986. 17p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701396.

In this paper the unsteady laminar free convection flow of a viscous incompressible fluid, past an accelerated infinite vertical porous plate subjected to a constant suction (or injection) is considered. Numerical results for the skin friction on the plate are obtained for the class of accelerated motions whose velocity is of the form U/sub O/t/sup n/ where t is time, U/sub O/ a constant and n is a positive integer. The skin friction tends to zero with increasing t when the Grashof number Gr=λ/sup 2/, the Prandtl number σ=1, n=0 and λ>0 which corresponds to suction. 12 refs, 2 figs, 1 tab.

21737 **(IC—86/25) Effect of submerged obstacles on circular fronts propagating into water at rest.** (International Centre for Theoretical Physics, Trieste (Italy)). Mar 1986. 10p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701397.

In this paper, the effect of vertical walled obstacles on circular fronts propagating on the surface of shallow water is discussed. The amplitude of the transmitted acceleration waves is determined together with a recurrence relation for the reflection and transmission coefficients at successive obstacle walls. 11 refs.

21738 **(IC—86/77) Potentials and scattering cross sections for collisions of He atoms with adsorbed CO.** (International Centre for Theoretical Physics, Trieste (Italy)). May 1986. 33p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87701388.

Ab initio calculations of the total scattering cross section for the collision system He -> CO/Pt(111) within the renormalized distorted wave Born approximation are reported. The interaction potential for this atom-adsorbate system consists of the usual two-body gas phase-like potential as well as two additional substrate mediated van de Waals contributions, all with similar long range behaviour. Comparison of the calculated cross sections for various incident velocities and angles with available experimental data is made without using any adjustable parameters to fit the data, and the importance of including the substrate-mediated forces is emphasized. 27 refs, 6 figs, 1 tab.

21739 **(IC—86/105) Oblique target transmission technique in measuring stopping powers.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701390.

The stopping powers for aluminium, nickel and gold for 1.0 to 5.0 MeV helium-3 have been measured using a technique known as Oblique Target Transmission (OTT), which has been developed to measure stopping powers. Data have been analyzed using an investigation method and results compared with semi-empirical calculations. A preliminary investigation to minimize energy spread of outgoing particles is also reported. 7 refs, 6 figs, 2 tabs.

21740 **(IC—86/130) Microwave TRAPATT oscillator properties.** (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1986. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701392.

A study of the operation of the TRAPATT diode oscillation as function of the diode parameters is given. Silicon diodes of both p/sup +/nn/sup +/ and n/sup +/pp/sup +/ structures are used and results are compared. A tunable circuit over the entire S-band frequency range is employed. The optimum performance is obtained at frequencies of 2.6 GHz and 3.65 Ghz. The diode-circuit interaction effects on the dc characteristics of the oscillator have been measured. It has been observed that the operating voltage of the TRAPATT oscillator is dependent to a great extent upon the circuitry than upon the diode used in the oscillator. The voltage collapse as function of the diode efficiency and a comparison of the power-efficiency for both p/sup +/nn/sup +/ and its complementary n/sup +/pp/sup +/ diodes are given. Finally the effects of the diode are on the RF power output and efficiency has been determined. 7 refs, 6 figs.

21741 **(IC—86/136) Calculation of the unsteady flow in vaneless diffusers by the partially-parabolic method.** (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1986. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701393.

Experimental investigations have shown that the flow discharged from a centrifugal compressor or pump impeller into the diffuser is unsteady and contributes for additional losses in the diffuser. The partially parabolic method is used to calculate this flow in the diffuser and reveals the mechanism of smoothing the distort-

ed flow downstream. Calculated results are compared with measurements and good agreement is found. 9 refs, 13 figs.

21742 **(IC—86/141) Surface phonon polaritons in semi-infinite semiconductor superlattices.** (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1986. 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701394.

Surface phonon polaritons in a semi-infinite semiconductor superlattice bounded by vacuum are studied. The modes associated with the polaritons are obtained and used to obtain the dispersion relation. Numerical results show that polariton bands exist between the TO and LO phonon frequencies, and are found to approach two surface mode frequencies in the limit of large tangential wave vector. Dependency of frequencies on the ratio of layer thicknesses is shown. Results are illustrated by a GaAs-GaP superlattice bounded by vacuum. 10 refs, 5 figs.

21743 **(IC—86/147) Uniformly valid asymptotic solution of the surface wave problem due to underwater sources.** (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1986. 19p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701395.

The two-dimensional linearized problem of surface waves in water of finite (or infinite) depth due to a stationary periodic source situated at a finite depth below the free surface, is considered. The formal solution of the problem is derived by using Laplace and Fourier transforms. A uniformly valid asymptotic expansion of the wave integral is obtained by using the method of Bleistein in the case of finite depth and that of Vander Waerden in the case of infinite depth. Physical interpretation of the results so derived is given. 9 refs.

21744 (INIS-SU—378, pp 35-38) **Behaviour of frequences of antiferromagnetic resonance in YFeO/sub 3/ in magnetic field.** Balbash, A.M.; Mandel'shtam, T.S.; Nikitin, S.I.; Prokhorov, A.S. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780101.

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In Experimental and theoretical physics. Collection.

The behaviour of two modes of antiferromagnetic resonance in YFeO/sub 3/ in the magnetic field up to 12 kE is investigated. It is shown that the main contribution to weak ferromagnetism in YFeO/sub 3/ is made by the antisymmetrical exchange.

21745 (INIS-SU—385, pp 51-55) **Example of antiphase fluctuation - negative electric current in dielectrics.** Yukalov, V.I. (Joint Inst. for Nuclear Research, Dubna, USSR. Lab. of Theoretical Physics). 1985. NTIS (US Sales Only), PC A04/MF A01. File Number DE87780104. (N—7-85).

In JINR rapid communications. Collection.

The possibility of the fluctuational appearance of an order parameter which is unusual for a given system is illustrated by the example when the electric current arising in an irradiated dielectric is directed opposite to the applied electric field. 10 refs.

21746 (INIS-SU—392, pp 545) **Study of distant magnetic order effect on Fesup(3+) cation vibrations in Usub(3)Fesub(5-x)Gdsub(x)Osub(12) ferrite garnets by NGR method.** Sinitsyn, S.V.; Spirin, A.N.; Uspenskij, M.N. 1986. (In Russian). NTIS (US Sales Only), PC A99/MF A01. File Number DE87780053. (CONF-8604278—Summs.).

From 36. conference on nuclear spectroscopy and nuclear structure; Khar'kov, USSR (15 Apr 1986).

21747 (INIS-SU—392, pp 573) **Defect center decay in $\gamma$-quantum irradiated lithium iodates.** Zakharyants, A.G.; Maloyan, A.G.; Ter-Minasyan, A.L. 1986. (In Russian). NTIS (US Sales Only), PC A99/MF A01. File Number DE87780053. (CONF-8604278—Summs.).

From 36. conference on nuclear spectroscopy and nuclear structure; Khar'kov, USSR (15 Apr 1986).

21748 **(IPEN-Pub—98) Determination of the Dauphine twinning volume fraction induced in a natural quartz crystal using neutron diffraction.** (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). Feb 1986. 15p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701399.

The Dauphine twinning volume fraction of a natural quartz crystal has been determined by neutron diffraction. The crystal shaped into a cylinder 5 cm height x 5cm diameter was submitted to the $\alpha$->$\beta$->$\alpha$ phase transformations before the measurements. Several intensity ratios I sub(hk.l) /I(sup(--) sub(hk.l)) were measured at room temperature, after the heat treatment employed in the phase transformations. The various pairs of reflections hk.l - hk sup(--) were chosen for their sensitivity as Dauphine - twinning indicators. The experimental intensity ratios were compared to theoretical curves, representing the variation of the ratio chemical bondF sub(hk.l) chemical bond/sup 2//chemical bondF(sub(hk) sup(--) sub(.l))chemical bond/sup 2/ as function of the Dauphine twinning volume fraction x, in order to obtain several values of x for the secondary Dauphine twinning produced by the inversion at 573/sup 0/C. An average value of x was found to be 0.5, which is commonly found in natural quartz. For comparison and evaluation of the method employed, the twinning volume fraction has also been determined for a synthetic quartz single crystal shaped into a 3cm x 3cm x 0.8cm orthogonal prism. For this sample the value of x was found to be 0.18, which is higher than usually found for synthetic quartz.

21749 **(JINR—14-85-893) Damage formation in synthetic diamond at high energy ion implantation.** (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1985. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701401.

Submitted to the journal Sov. Phys. - Semicond. .

Damage structure in synthetic diamond irradiated with carbon ions at 82 MeV within the 10sup(14) - 10sup(16) cmsup(-2) dose range was investigated by the cathode- and photoluminescence methods. Significant influence of crystal lattice damages on spectral characteristics of optic active centers has been found. It manifests itself in broadening of phononless lines in luminescence spectra (from 2 upto 17 MeV for the 575 nm centre line) and weakening of electron-phonon interaction. Dose dependence of phononless lines of luminescence centres has a threshold character with a critical dose in the 3 x 10sup(15) cmsup(-2) region. 10 refs.; 6 figs.

21750 **(JINR—R-14-85-726) Neutron diffraction study of Ba(TiCo)/sub 2/Fe/sub 8/O/sub 19/ magnetic structure.** (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1985. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701493.

From 8. Conference on neutron application in solid physics; Riga, USSR (1985).

The neutron diffraction analysis of the Ba(TiCo)/sub 2/Fe/sub 8/O/sub 19/ compound in the temperature range from 4.2 to 290 K is carried out. Co-existence of the heliocoidal magnetic structure of the SS-type and the collinear antiferromagnetic one is found-out. The helicoidal structure has a block character, the spiral coherence length along c vektor axis is approximately 150 A at T = 77 K, the spiral period is incommeasurable with the atomic one all over the temperature range and increases beginning from 36 A at T = 4.2 K upto 210 A at T = 290 K. The dimension of regions with antiferromagnetic ordering is not less than 500 A. The supposition is made that the character of the Ba(TiCo)/sub 2/Fe/sub 8/O/sub 19/ magnetic structure is due to inhomogeneity of Fe/sup 3+/ ion substitution in nonequivalent crystallographic positions occurring at low (Ti+Co) concentrations. 6 refs.; 6 figs.

21751 **(NAC—86-03) Doping of silicon by laser-induced diffusion.** (Council for Scientific and Industrial Research, Pretoria (South Africa). National Accelerator Centre). 1986. 19p. (In English and Afrikaans). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701400.

This report gives information on the doping of silicon by laser-induced diffusion, modelling and heat-flow calculation, doping from evaporated layers and silicon self-diffusion during pulsed laser

irradiation. In order to tailor dopant profiles accurately a knowledge of the heat flow and the melt depths attained as a function of laser energy and material type is crucial. The heat flow calculations described can be used in conjuntion with most diffusion equations in order to predict the redistribution of the deposited dopant which occurs as a result of liquid phase diffusion during the melting period. Doping of Si <100> was carried out by evaporating thin films of Sb, In and Bi 10 to 300 A thick, onto the substrates. During pulsed laser irradiation the dopant film and underlying silicon substrate is melted and the dopant incorporated into the crystal lattice during recrystallization. Radioactive /sup 31/Si(T1/2=2,62h) was used as a tracer to measure the self-diffusion of silicon in silicon during pulsed laser (pulsewidth = 30ns, wavelength = 694nm) irradiation.

21752 **(PNL-SA—14175) Raman characterization of molecular bonding and phase homogeneity in thin optical films.** Exharos, G.J. (Pacific Northwest Lab., Richland, WA (USA)). Jul 1986. Contract AC06-76RL01830. 9p. (CONF-860880—47). NTIS, PC A02. File Number DE87006400.

From 30. SPIE technical symposium on optics and optoelectronic engineering; San Diego, CA, USA (17 Aug 1986).

Submicrometer dielectric films have been analyzed by Raman spectroscopic techniques with respect to phase composition and homogeneity. Residual film stress has also been evaluated from measured vibrational band shifts in sol-gel as well as sputter-deposited films using available data from bulk studies of the pressure dependence on Raman frequencies. Dynamic studies of temperature and laser-induced phase transformations have been performed in situ, suggesting the applicability of this technique for film analysis during deposition. The potential advantages and limitations associated with Raman characterization of thin dielectric films will be addressed in this review using examples from current research in this area. 22 refs., 9 figs.

21753 **(SAND—86-2471C) Molecular reactions at the film surface in plasma polymerization.** Buss, R.J. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 10p. (CONF-870410—4; CONF-870410—4). NTIS, PC A02/MF A01; GPO Dep. File Number DE87002488.

From 193. national meeting of the American Chemical Society; Denver, CO, USA (5 Apr 1987).

During the plasma polymerization process, the surface of the depositing material is continuously bombarded by a multitude of plasma generated species: ions, photons, radicals and other neutral molecules. In understanding the chemistry of the plasma polymerization process it is desirable to know the way in which these species interact with the film during deposition. Any individual molecule/surface collision may result in growth of the film by an attachment reaction, or in ablation by chemical or physical removal of previously attached atoms. Reported here are results of experiments designed to probe the reaction of molecules undergoing single collisions with the surface of a plasma-polymerized film during the deposition process. The method employed was a molecular beam sampling of all the plasma species and deposition of polymer from the beam onto a substrate. Control of the charged particle fluxes to the surface was used to study the role of ion bombardment. A beam of a probe molecule, incident on the film surface throughout the deposition, was used to investigate the interaction of the probe molecule with the surface. 6 refs., 3 figs.

21754 **Atomistic study of structural metastability in coherently strained Si-like layers.** Dodson, B.W. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 11, 5558-5562(15 Apr 1987).

Comparison of experimental values for critical mismatch of coherently strained semiconductor films with the predictions of equilibrium theories suggests that metastable structures with much greater critical mismatch than predicted by equilibrium theory can often be grown in practice. One possible mechanism for loss of coherence in such metastable structures is the generation of misfit dislocations in an initially perfect overlayer by nucleation of half-loop of misfit dislocation at the surface of the strained layer. The mismatch threshold for zero-temperature loss of coherence associated with this half-loop dislocation nucleation mechanism, which does not occur in the continuum model, is calculated using atomistic Monte Carlo techniques on a coherently strained layer composed of a model siliconlike material. The instability threshold for a 10-A-thick layer is found to be 11.2%, compared to the equilibrium critical mismatch of about 4%. Possible extensions of this approach to the problem of practical stability of coherently strained structures are discussed.

21755 **Self-affine fractal model for a metal-electrolyte interface.** Kaplan, T.; Gray, L.J.; Liu, S.H. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6032). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 10, 5379-5381(1 Apr 1987).

Fractal models of rough interfaces have provided a possible explanation for the observed ac response of an interface between a metal and an electrolyte with blocking contacts which displays the constant-phase-angle (CPA) behavior. For this system, two different relations between the exponent eta of the frequency dependence of the CPA element and the fractal dimension d/sub s/ of the interface have been proposed. By solving for the properties of a self-affine fractal model of an interface and using Mandelbrot's box dimension for the fractal dimension it is demonstrated that there is no universal relation in which eta is simply a function of d/sub s/.

21756 **Secondary-ion emission from vanadium as a function of incident ion mass and energy in the range 25—275 keV.** Blauner, P.G.; Weller, R.A. (A.W. Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06511). *Physical Review* [*Section*] *B: Condensed Matter;* **35**: No. 4, 1485-1491(1 Feb 1987).

Measurements of the intensities of low-energy secondary ions emitted from clean and oxidized polycrystalline vanadium surfaces under (25—275)-keV $He^+$, $Ne^+$, $Ar^+$, and $Kr^+$ bombardment are reported. Whereas the intensities of the metallic-ion species are observed to be proportional to the sputtering yield of vanadium and, therefore, dependent on elastic energy deposition, the intensities of $O^+$ ions are not. Rather, they increase linearly with increasing projectile velocity in a manner similar to the electronic stopping power or, equivalently, to the yield of secondary electrons. While the production of metallic ions may be described adequately by a number of the proposed models of secondary-ion emission, that of $O^+$ cannot. The possibility that $O^+$ is produced by a mechanism similar to electron-stimulated desorption is discussed.

21757 **Transition from free molecule to collisional flow during vaporization into vacuum by the test-particle method.** Tsai, C.; Olander, D.R. (Department of Nuclear Engineering, University of California and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Physics of Fluids;* **30**: No. 2, 386-392(Feb 1987). Contract AC03-76SF00098.

A test-particle method was developed to estimate the conditions that lead to collision-dominated evaporation during pulse heating of a solid surface in vacuum. The method consists of calculating the number density of evaporated molecules above the surface neglecting collisions and then sending a test particle through this cloud. The probability that the test particle escapes from the cloud without making a collision is the measure of the importance of intermolecular collisions during the blow off. The method is applied to heating of a —1 cm diam spot on the surface with a heat pulse of —1 msec duration. These conditions characterize laboratory laser vaporization experiments intended to measure the vapor pressures of refractory solids at very high temperatures. The principal variable which determines the escape probability is the maximum surface temperature during the transient. When applied to laser heating of uranium dioxide, collisional effects in the vapor are predicted to begin at a maximum surface temperature between 2600 and 2800 K.

21758 **Time dependence of desorbed ground-state lithium atoms following pulsed-electron-beam irradiation of lithium fluoride.** Green, T.A.; Loubriel, G.M.; Richards, P.M.; Tolk, N.H.; Haglund R.F. Jr. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Physical Review [Section] B: Condensed Matter;* **35**: No. 2, 781-787(15 Jan 1987).

Recent experiments have shown that during the irradiation of lithium fluoride crystals by a chopped electron beam the signal of desorbed ground-state lithium atoms continues for times up to seconds in the beam-off period. A quantitative model is presented which connects the desorption of lithium atoms with the diffusion of lithium fluoride F centers to the surface. The model thus introduces a new source of time delay (F-center diffusion) in the desorption of ground-state metal atoms from alkali halides. Formerly it has been supposed that the delay occurred entirely during the surface desorption step. The model fits the experimental data very well, and should be applicable to other similar systems. For the cases considered here, F-center diffusion turns out to be the primary source of delay in the Li-atom signal. The model suggests some new directions for investigation.

21759 **Stability of dendritic crystals.** Kessler, D.A.; Levine, H. (Department of Physics, University of Michigan, Ann Arbor, Michigan 48109). *Physical Review Letters;* **57**: No. 24, 3069-3072(15 Dec 1986).

We present an integrodifferential-operator formulation of the problem of linear stability around the selected needle crystal pattern in dendritic crystal growth. We show by explicit computation that (a) all members of the discrete set of allowed steady states aside from the fastest are unstable and (b) the fastest such shape is linearly stable at least for large enough anisotropy. We comment on the implications of our work for the issue of side-branch wavelength determination.

21760 **Effective mass of neutrons diffracting in crystals.** Zeilinger, A.; Shull, C.G.; Horne, M.A.; Finkelstein, K.D. (Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Physical Review Letters;* **57**: No. 24, 3089-3092(15 Dec 1986).

Neutrons propagating in a crystal under diffraction conditions exhibit an effective inertial mass which is lower by 5—6 orders of magnitude than their vacuum rest mass and of both positive and negative sign. This is verified experimentally by measurement of the enormously enhanced deflection of neutrons subjected to a magnetic force while passing through a silicon crystal.

21761 **Distance of excited-state formation in ion-surface collisions.** Burgdoerfer, J.; Kupfer, E. (University of Tennessee, Knoxville, Tennessee 37996 and Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review Letters;* **57**: No. 21, 2649-2652(24 Nov 1986). Contract AC05-84OR21400.

We present the first numerical results of a multichannel theory for resonant charge exchange in ion-surface scattering at grazing incidence. The time-dependent Schroedinger equation describing resonant exchange can be solved in the adiabatic approximation for the slow perpendicular motion. As an initial application the state dependence of the distance of formation in the H($n = 2$) following specular reflection of protons at a gold surface is determined.

21762 **Dislocation generation in the two-dimensional Frenkel-Kontorova model at high stresses.** Lomdahl, P.S.; Srolovitz, D.J. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review Letters;* **57**: No. 21, 2702-2705(24 Nov 1986).

Dislocation generation is studied in a generalized two-dimensional Frenkel-Kontorova model which allows consideration of dislocations of arbitrary Burgers vector and line shape. Two new mechanisms for dislocation generation at high stresses have been found: (1) heterogeneous nucleation of dislocations on preexisting dislocations and (2) generation of dislocation loops in the wake of a moving dislocation. These new mechanisms provide an understanding of how materials generate the density of dislocations required to accomodate arbitrary strains at high strain rates.

21763 **Tunneling exchange, supersymmetry, and Riccati equations.** Kumar, P.; Ruiz-Altaba, M.; Thomas, B.S. (Department of Physics, University of Florida, Gainesville, Florida 32611). *Physical Review Letters;* **57**: No. 21, 2749-2751(24 Nov 1986).

We propose a variational formalism, based on supersymmetry, for the calculation of the tunneling exchange integral. Good numerical results are obtained with minimal effort.

21764 **Ab initio calculation of coverage-dependent adsorption properties of H on Pd(001).** Tomanek, D.; Louie, S.G.; Chan, C. (Department of Physics, University of California, Berkeley and Center for Advanced Materials, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Physical Review Letters;* **57**: No. 20, 2594-2597(17 Nov 1986). Contract AC03-76SF00098.

The preferential adsorption sites, bond lengths, and vibration frequencies for H on the Pd (001) surface are determined by use of the ab initio pseudopotential local-orbital method. From the calculated total energies we derive a coverage-dependent adsorption energy in very good agreement with experiment. We establish that at low coverages ($\theta \leq 1$), H occupies fourfold hollow sites. At higher coverages ($1 < \theta \leq 2$), islands of bridge-bonded H (local coverage $\theta = 2$) are predicted to coexist with regions of H in hollow sites.

21765 **Electrical conductivity of a strongly coupled plasma.** Rinker, G.A. (Los Alamos National Lab., NM). *Physical Review [Section] B: Condensed Matter;* **31**: No. 7, 4207-4219(1 Apr 1985).

This is the first in a series of papers concerning the electrical and thermal transport properties of dense plasmas. Temperatures and densities considered range approximately from room temperature to $10^4$ eV and from $10^{-4}$ to $10^4$ times compressed. In the present work they describe theoretical calculations of electrical conductivities using the t-matrix version of the Ziman theory with various self-consistent ionic potential models and realistic structure factors. The theoretical basis is described, and illustrative results are given.

21766 **Molecular-dynamic simulations of many-particle systems: new faces on old problems.** Wallace, D.C. (Los Alamos National Lab., NM). pp 521-563 of Electronic structure, dynamics, and quantum structural properties of condensed matter. Devreese, J.T.; Van Camp, P. (eds.). New York, NY; Plenum Publishing Corporation (1985).

Computer simulation techniques of the molecular dynamics of many-particle condensed matter systems are described. A basic description of equilibrium molecular dynamics is given and methods of data analysis are discussed. Calculations of metallic sodium are presented as an example of the type of data to be expected from molecular dynamic techniques.

21767 **Moessbauer-effect isomer shifts.** Shenoy, G.K. (Argonne National Lab., IL). pp 57-76 of Moessbauer spectroscopy applied to inorganic chemistry. Vol. 1. Long, G.J. (ed.). New York, NY; Plenum Publishing Corporation (1984). Contract W-31-109-ENG-38.

Perhaps the most significant aspect of Moessbauer spectroscopy is the discovery of the isomer shift. The measurement of the isomer shift provides unique information regarding the nature of the chemical bond, not easily available from other microscopic techniques. It would be no exaggeration to say that the isomer shift measurements have provided a new depth in the qualitative and quantitative evaluation of the chemical structure of condensed systems. In this chapter an exposition of the isomer shift is presented without recourse to vigorous mathematical formulations. The procedures used in the calibration of the isomer shift scale are discussed with some illustrations. The reader is presented with examples of the use of the isomer shift in the evaluation of chemical structures with specific discussions on various correlations.

21768 **Trace surface analysis with Pico-Coulomb ion fluences: direct detection of multiphoton ionized iron atoms from iron-doped silicon targets.** Pellin, M.J.; Young, C.E.; Calaway, W.F.; Gruen, D.M. (Argonne National Lab., IL). *Surface Science;* **144**: 619-637(1984).

A system for surface analysis is described which has the objective of maximizing the probability of detection of atoms sputtered from the sample. Resonance ionization techniques have been combined with pulsed ion-induced erosion to detect and count Fe atoms sputtered from Fe and Fe in Si samples without the interposition of a mass spectrometer between the target and the detector (direct detection). At present, surface analysis by resonance ionization of sputtered atoms (SARISA) allows determination at the fifty parts per million (ppm) level of Fe doped into Si with removal of less than $10^{-5}$ of a monolayer. Separation of the Fe impurity from the isobaric $Si_2$ dimers is accomplished in the resonant photo-excitation step. Improvements in the method are suggested which, if successful, would bring the sensitivity into the parts per billion (ppb) range with primary ion currents remaining low enough to produce negligible surface damage. The quantitative and element specific nature of the SARISA technique is established by demonstrating that the ground state neutral fraction is essentially unchanged in two very different matrixes (Fe and Si). Also presented are measurements of the low-lying excited state fraction of Fe atoms sputtered both from an Fe and a Si matrix. 45 references, 5 figures, 2 tables.

21769 **Nonlinear optical probes of interfaces.** Heinz, T.F.; Tom, H.W.K.; Shen, Y.R. (Lawrence Berkeley Lab., CA). *Laser Focus;* vp(May 1983). Contract AC03-76SF00098.

The laser has become an indispensable tool for investigating the bulk properties of matter, but it has not been widely exploited in the study of surfaces and interfaces. During the last few years, however, several promising applications of lasers to surface science have appeared. One line of research takes advantage of the laser's ability to probe surfaces and interfaces. Lasers can, for example, be used to obtain information about the molecule/surface interaction by detecting transitions in molecules scattered from surfaces. Laser-induced desorption and surface photoacoustic spectroscopy can yield vibrational spectra of molecules adsorbed on surfaces. Considerable progress has also been made in the development of surface probes based on nonlinear optical effects. These purely optical methods have an important role to play in surface studies. Unlike the conventional probes of surface science, which rely on the emission, absorption, or scattering of massive particles, they are generally applicable to interfaces between two dense media and, therefore, offer some unique and intriguing possibilities. In this article, a brief discussion of these techniques is given.

21770 **Interaction of monoenergetic positrons with solid surfaces.** Dale, J.M.; Hulett, L.D. Jr.; Pendyala, S. (Oak Ridge National Lab., TN). *Applied Spectroscopy Reviews;* **19**: No. 1, 105-165(1983). Contract W-7405-ENG-26.

A review of the theory and applications of positron interactions with solid surfaces is presented. After a general introduction to positrons the author describes the development of monoenergetic positron sources from a historical perspective. Positron detection is then discussed. Other sections review applications to the study of solids via diffraction and surface spectroscopy and positron studies in atomic and molecular physics.

## 6561 Superconductivity

*REFER ALSO TO CITATION(S) 20564, 20622, 20669, 20689, 20695, 21456*

## 6570 Theoretical And Mathematical Physics

*REFER ALSO TO CITATION(S) 20745, 20893, 21724, 22068*

21771 **(CONF-870424—3) Multidimensional linear-linear nodal transport methods in weighted diamond difference form.** Azmy, Y.Y. (Oak Ridge National Lab., TN (USA)). Jan 1987. Contract AC05-84OR21400. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004399.

From American Nuclear Society international meeting on advances in reactor physics, mathematics and computation; Paris, France (27 Apr 1987).

A computer program that solves two-dimensional transport problems using the LN (linear nodal), LL (linear linear), or the BL (bi-linear) method was written and was used to solve two simple test problems. The results are used here to confirm our algebraic manipulations of the nodal equations and also to compare the performance of the three methods from the computational, as well as the theoretical, point of view. The three methods are found to have comparable accuracies, especially on meshes that are sufficiently fine. It is apparent that a given method will be more appropriate to use for solving certain problems than the other two methods, depending on the specifications of the problem.

21772 **(CONF-8608157—2) Thermodynamic properties of molten salt solutions.** Blander, M. (Argonne National Lab., IL (USA)). 15 Aug 1986. Contract W-31109-ENG-38. 39p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87004948.

From Advanced study institute on molten salt chemistry; Camerino, Italy (3 Aug 1986).

Why is it important to understand the thermodynamic properties of molten salt solutions, and what aspect of these properties is most important. In technologies and sciences where molten salts, slags or magmas are used or studied, one often must calculate the extent of a chemical reaction or of phase equilibria. In order to do this we need to know an equilibrium constant which can be generally written as $\Delta G^0 = RT\ln K$. The equilibrium constant K is a function of compositions and activity coefficients, the two quantities necessary to define chemical potentials, $\mu$ K = K(X,$\gamma$). Thus, in order to calculate the concentrations of the final equilibrium product, X, one needs a knowledge of $\Delta G^0$ and of the activity coefficients $\gamma$. The calculation of $\Delta G^0$, the standard free energy change for reactants and products in their standard states (generally the pure salts) is obtained from calorimetric data or other types of equilibrium data on pure compounds. I will not touch on this since this is another field and a large fraction of the data molten salt chemists need is already available. This paper investigates a way to calculate activity coefficients using chemical potentials. Mathematical models are presented for binary and ternary mixtures.

21773 **(CONF-8609254—1) Physics with magnetic charges and electric currents.** Lipkin, H.J.; Peshkin, M. (Argonne National Lab., IL (USA); Weizmann Inst. of Science, Rehovoth (Israel)). Sep 1986. Contract W-31109-ENG-38. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87004666.

From ISQM Tokyo '86; Tokyo, Japan (1 Sep 1986).

Hamiltonian theories with magnetic charges and electric currents exhibit paradoxes related to, but different from, those in theories with magnetic and electric charges. Investigation of these new paradoxes yields new insights into the physics obtained when both kinds of charges and currents are allowed. The electric charge in the Dirac quantization condition appears as the time integral of a current instead of as a coupling constant in the Lagrangian or Hamiltonian. 3 figs.

21774 **(DOE/ER/13123—3) Investigation of perturbation techniques for nonlinear difference equations and other related topics: Final technical report.** Mickens, R.E. (Atlanta Univ., GA (USA). Dept. of Physics). 29 Oct 1986. Contract AS05-83ER13123. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006663.

Investigations in mathematical physics are summarized for projects concerning a nonlinear wave equation; a second-order nonlinear difference equation; singular, nonlinear oscillators; and numerical instabilities. All of the results obtained through these research efforts have been presented in seminars and professional meetings and conferences. Further, all of these results have been published in the scientific literature. A list of exact references are given in the appendices to this report.

21775 **(DOE/ER/13178—3) Fundamentals and techniques of nonimaging optics research at the University of Chicago: Technical progress report.** Winston, R.; O'Gallagher, J. (Chicago Univ., IL (USA)). 6 Nov 1986. Contract FG02-84ER13178. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006917.

Nonimaging Optics differs from conventional approaches in its relaxation of unnecessary constraints on energy transport imposed by the traditional methods for optimizing image formation and its use of more broadly based analytical techniques such as phase space representations of energy flow, radiative transfer analysis, thermodynamic arguments, etc. Based on these means, techniques for designing optical elements which approach and in some cases attain the maximum concentration permitted by the Second Law of Thermodynamics were developed. The most widely known of these devices are the family of Compound Parabolic Concentrators (CPC's) and their variants and the so called Flow-Line or "trumpet" concentrator derived from the geometric vector flux formalism developed under this program. Applications of these and other such "ideal" or "near-ideal" devices permits increases of typically a factor of four (though in some cases as much as an order of magnitude) in the concentration above that possible with conventional means. A comprehensive review of the development of the whole field through mid-1983 was presented in the previous renewal proposal and will not be repeated here. In the most recent phase, our efforts can be classed into two main areas; (a) "classical" geometrical nonimaging optics; and (b) logical extensions of nonimaging concepts to the physical optics domain. 8 refs., 1 fig.

21776 (IA—1421, pp 3-4) **Statistical thermodynamics of charged objects. General method and applications to simple systems.** Rosenfeld, Y.; Blum, L. (Israel Atomic Energy Commission, Tel Aviv; Puerto Rico Univ., Rio Piedras). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21777 (IA—1421, pp 4-5) **Improved regula falsi method for solving the Schrodinger equation with a piecewise constant potential.** Friedman, M.; Rabinovitch, A. (Israel Atomic Energy Commission, Tel Aviv; Ben-Gurion Univ. of the Negev, Beersheba, Israel). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21778 (IA—1421, pp 12) **Spontaneous alignment in charged-particle systems. Fixed length vs. micellar situations.** McMullen, W.E.; Gelbart, M.; Rosenfeld, Y. (California Univ., Los Angeles, USA; Israel Atomic Energy Commission, Tel Aviv). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21779 (IA—1421, pp 12-13) **Internal heat distribution of an irradiated sphere.** Bar-Ziv, E.; Gorin, B.S.; Sarofim, A.F.; Longwell, J.P.; Spjut, R.E. (Israel Atomic Energy Commission, Tel Aviv; Massachusetts Inst. of Tech., Cambridge, USA). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21780 **(IA—1421) Research laboratories annual report 1985.** (Israel Atomic Energy Commission, Tel Aviv). Jun 1986. 265p. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
Separate abstracts were prepared for 16 papers in this report.

21781 **(IC—86/54) Nonmetricity and torsion: Facts and fancies in gauge approaches to gravity.** (International Centre for Theoretical Physics, Trieste (Italy)). Apr 1986. 41p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87701352.

In general relativity, the Riemannian connection of spacetime is symmetric and metric-compatible. If we relax at first the symmetry, we arrive at a Riemann-Cartan spacetime U/sub 4/ with torsion. If we relax, additionally, the metric-compatibility, then we are led to a metric-affine spacetime (L/sub 4/,g) with nonmetricity and torsion. In Part 1 we turn to the (L/sub 4/,g) spacetime and review an appropriate framework for corresponding gravitational model theories. They can be understood as gauge approaches to the 4-dimensional affine group GL(4,R)xR/sup 4/. They embody, in addition to the ordinary "weak" gravitational field, a "strong" piece, which is mediated by the connection and coupled to the hypermomentum current. In Part 2, by putting the nonmetricity to zero, we turn to the subcase of the Poincare gauge theory. We show in some detail, how this dynamic torsion theory can look effectively Einsteinian from a macroscopic point of view. This applies also to the Einstein-Cartan theory, which is a special case of the Poincare gauge theory for "frozen" torsion. In Part 3 we present new exact solutions of the Poincare gauge theory with mass, electric charge, and NUT-parameter. The properties of the new solutions are discussed. 207 refs, 8 figs.

21782 **(IC—86/61) On the prolongation approach in three dimension for the conservation laws and lax-pair of B-O equation.** (International Centre for Theoretical Physics, Trieste (Italy)). May 1986. 11p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701346.

The prolongation structure approach of Whalquist and Estabrook is used effectively in a new situation in relation to the integrodifferential type B-O equation (the Benjamin-Ono equation). The main clue lies in the possible differential equation representation of such equations in three dimension. Here it is shown how the usual analysis of prolongation structure can be utilized to deduce a Lax-pair for B-O type equation in three dimension. Effectiveness of the present approach is further demonstrated by an independent-derivation of some conservation laws associated with the equation. Lastly we reduce the whole formalism to two dimension to make contact with known results. 6 refs.

21783 **(IC—86/76) Painleve analysis for a class of coupled KdV system.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701347.

We have made a Painleve analysis for some coupled KdV systems, other than that of Hirota and Satsuma. These equations are interesting from many aspects. Due to the coupling with the other non-linear equation sometimes the singularity on the solution manifold becomes logarithmic. Also it is seen that the position of the resonances depends upon the coupling parameters. We have analysed in detail the structure of resonances and the formation of the coefficients at the resonance positions following the methodology of Ablowitz et al. 7 refs.

21784 **(IC—86/78) Integrability of classical and semiclassical derivative non-linear Schroedinger equation with non-ultra-local canonical structure.** (International Centre for Theoretical Physics, Trieste (Italy)). May 1986. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701348.

Derivative non-linear Schroedinger equation exhibiting non-ultra-local canonical structure is investigated to obtain various relationships including classical r-s matrices and Yang-Baxter relation modified by the non-ultra-locality. The complete integrability of the system is established through explicit action-angle canonical variables. An attempt has been made to solve the corresponding quantum field model in the semiclassical approximation. A possibility of eliminating non-ultra-locality of the model, necessary for exact quantum inverse scattering treatment, is demonstrated. 17 refs.

21785 **(IC—86/80) Exact realization of the Kac-Moody algebra.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701349.

The Kac-Moody generators are explicitly realized as functional differential operators expressed in terms of the co-ordinates of the (infinite dimensional) group manifold. As an application of

this realization, the two-dimensional Wess-Zumino chiral action is derived from the Hamiltonian formulation. 14 refs.

21786 **(IC—86/90) Some existence theorems of critical points and applications.** (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1986. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701350.

In this paper we will go into details of some existence theorems of critical points given recently. As applications, we consider the semilinear elliptic boundary value problem which has been investigated extensively in the last twenty years. 11 refs.

21787 **(IC—86/117) Operational method for the particle slowing down problem.** (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1986. 10p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701343.

The direct operational method is used to transform the collision integral in the transport equation to a polynomial in derivatives with respect to lethargy. This polynomial is approximated by the Pade approximation technique. Different orders of Pade approximation give the well-known synthetic kernel. This procedure reduces the integro-differential form of the transport equation to differential form. It also gives us the possibility to consider energy dependent cross-section and to get the solution without using the integral transform method. We shall consider here the solution for infinite homogeneous medium and calculate the energy deposition factor for different orders of the Pade approximant. 5 refs, 2 tabs.

21788 **(IC—86/121) Schroedinger differential operator and intrinsic self adjointness.** (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1986. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701344.

An attempt is made to establish a hermitization procedure for rendering any linear differential operator to be intrinsically self adjoint, independently of any prescribed representation. This is accomplished by introducing an associate differential operator, which is simply a linear combination of all the individual ordinary differential operators belonging to the adjoint of the given linear differential operator, that satisfies the criterion of intrinsic self adjointness. It turns out that the associate differential operator is capable of generating an infinite set of hermitized versions of any arbitrary linear differential operator. Both momentum and kinetic energy differential operators that belong to the Schroedinger wave equation are rendered self adjoint. 10 refs.

21789 **(IC—86/122) Solitary waves in one-dimensional damped systems.** (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1986. 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701345.

An analysis of general properties of travelling waves that can exist in one-dimensional damped systems is presented. It is shown that depending on the symmetry of the potential and the presence or absence of dissipation different classes of localized solutions in the form of kinks, pulses and semisolitons are possible. 11 refs, 5 figs.

21790 **(IFVE-OTF—85-115) Compact and noncompact gauge symmetries in N=2 supergravity.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 16p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700911.

Submitted to the journal Nucl. Phys. .

The interaction of vector and scalar multiplets with N=2 supergravity is considered for the case when vector multiplets interact in a minimal way, and scalar ones correspond to non-linear $\sigma$-models of the type. Sp(2,2n)/Sp(2n)xSp(2n), SU(2, n)/SU(2)xSU(n)xU(1) and O(4, n)/O(4)xO(n). It is shown, that in these cases the gauge interactions of vector and scalar mesons may be introduced, in this the gauge may be either compact or noncompact. Several interesting concrete examples are given. 8 refs.

21791 (INIS-mf—10565, pp 29-33) **On gauge transformations of the arbitrary Sobolev class.** Solov'ev, M.A. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780085.

Kratkie Soobshcheniya po Fizike. No. 3.

In Experimental and theoretical physics. Collection.

It is proved that the group of gauge transformations of the arbitrary Sobolev class operates continually and properly in the corresponding space of fields. If these group does not form the Lie group and is just a topological one, this space is not included into the Sobolev type except two boundary cases.

21792 (INIS-SU—378, pp 57-60) **Integrable equations related to SU(m/n) superalgebra.** Andreev, V.A. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780101.

Kratkie Soobshcheniya po Fizike. No.2.

In Experimental and theoretical physics. Collection.

In the study L-A pairs for supersymmetric equations related to SU(m/n) superalgebra have been derived. As initial mode the Liouville supersymmetric equation has served.

21793 **(INIS-SU—378) Experimental and theoretical physics. Collection.** (AN SSSR, Moscow. Fizicheskij Inst.). 1985. 73p. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780101.

Kratkie Soobshcheniya po Fizike. No. 2.

Separate abstracts were prepared for 2 papers in these proceedings. (DWL)

21794 (INIS-SU—398, pp 42-60) **Grassman and para-Grassman variables and spin 1 massless particle dynamics.** Gershun, V.D.; Tkach, V.I. 1985. (In Russian). NTIS (US Sales Only), PC A05/MF A01. File Number DE87780090.

In Problems of nuclear physics and cosmic rays. No. 23. Republican Interinstitute scientific technical collection.

Lagrangian formalism and Poisson bracket formalism are generalized in case of the system described by a set of c-numerical values qsub(i)(i=1...n) and para-Grassman variables THETAsub($\alpha$)($\alpha$=1...N). Motion of massless particles with spin 1 both in para-Grassman and Grassman cases is considered in detail. The both variants are shown to lead to analogous description of the free massless particle with spin 1 in terms of the Daffin-Kemmer equation. 9 refs.

21795 (INIS-SU—398, pp 73-80) **On power-type cosmological solutions of the Brans-Dicke theory.** Roman'kov, V.V. 1985. (In Russian). NTIS (US Sales Only), PC A05/MF A01. File Number DE87780090.

In Problems of nuclear physics and cosmic rays. No. 23. Republican Interinstitute scientific technical collection.

Analysis of power-type cosmological solutions of the Brans-Dicke theory (BDT) is carried out. The observed data testify to the fact that the real Universe, beginning from the stage preceding nucleon synthesis and up-to nowadays, should be described either by Friedman or cosmological solutions in the form of rather similar to them. In the BDT such solutions are those, which transfer at free parameter values $\omega$ -> infinity into Friedman ones. The rest solutions can be considered as nonphysical ones. The BDT is shown to disagree fully with the Mach principle.

21796 **(ITEF—19(1985)) Some estimates in analytic theory of Hill absolute stability.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 34p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87700966.

In frames of special "analytic" theory of Hill absolute stability in unbounded three-body problem (which is logically considered independent of a more general "geometric" stability theory) some new convenient parameters are introduced. Evident algebraic form of the theory basic equation is obtained. A new more exact estimation of the distance between bodies forming stable Hill pair is given. Efficiency of analytical theory developed here and earlier is tested on eight most interesting subsystems of three bodies within solar system (both considered earlier and relatively new), i.e. tasks are quite real. Broad numerical investigation became possible due to operation of a special BESM-6 computation program. In one case absolute Hill stability is firstly unexpected. In five out of seven the rest absolute Hill stability in the motion of corresponding body

pairs takes place and is resulted from the determined sufficient conditions. 21 refs.

21797 **(JINR—E-2-86-15) Quantum motion on a halfline connected to a plane.** (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1986. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701351.

Free motion of a particle on a manifold which consists of a one-dimensional and a two-dimensional parts connected in one point is treated. The class of admissible Hamiltonians is found using the theory of self-adjoint extensions. A particular attention is paid to those of them which allow the particle to pass through the point singularity; the reflection coefficient and other quantities characterizing scattering on the connection point are calculated. A possible physical application is discussed purpose the para-axial equations of motion, including charge exchange effects, has been studied for the system consisting of the quadrupole lenses. The dependence of final cross-over on beam current is discussed. 14 refs.; 2 figs.

21798 **(KFKI—1986-30/A) Universal master equation for the gravitational violation of quantum mechanics.** (Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics). Jun 1986. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701353.

A possible approach to the future unification of gravity and quantum theories is proposed: the effect of gravity on the propagation of quantum mechanical wave packets. The proposed master equation modifying the equation of motion for the density operator describes the gravitational damping of nondiagonal, state-mixing components. The relaxation time is determined by the non-overlapping of mass density distributions of the interfering quantum states. The estimation of the characteristic spatial and temporal sizes of the effect shows that in the case of nucleons and atoms the damping effect is ignorable, in the case of colloid grain particles the coherence radius of the wave packets is comparable with the physical size of the particle, and in the case of macroscopic objects the gravitational damping presses the wave function into a well-defined, well-separable classical state. The form and parameters of the Hawking indeterminancy of the gravitational field. (D.Gy.). 13 refs.

21799 **(LA-UR—87-519) Some progress in statistical turbulence theory.** Kraichnan, R.H. (Los Alamos National Lab., NM (USA)). 1987. Contract W-7405-ENG-36. 37p. (CONF-870359—1). NTIS, PC A03/MF A01; GPO Dep. File Number DE87006058.

From 5. seminar on magnetohydrodynamic flows and turbulance; Jerusalem, Israel (2 Mar 1987).

An examination is made of relationships among several approaches to analytical turbulence theory: approximation by finite sets of moments, renormalized perturbation theory, decimation under symmetry constraints, renormalization-group methods, and the upper-bounding of transport under integral constraints. Most of the discussion assumes isotropic turbulence. Decimation under symmetry constraints plays a unifying role. It promises a rational basis for renormalized perturbation theory and provides links to the other named approaches. 72 refs.

21800 **(LAFI—075) Large order perturbation theory for the Coulomb angular spheroidal equation.** (AN Latvijskoj SSR, Riga. Inst. Fiziki). 1985. 28p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87701342.

The nature of perturbation theory for the Coulomb angular spheroidal equation (CASE) is considered. It has been shown that along with the power members of approximately (1/4p)sup(k), p - > infinity, there could be present approximately esup(-2sp) members and the integer of s >=1 in asymptotic expansion of eigenvalues. Coefficients of eigenvalue expansion into a power series of 1/4p have been found to be asymptotic by number, that allows to analyse the obtained CASE solutions for all the possible real values of the $\sigma$ parameter. The results obtained are used for studying electron terms of the Z/sub 1/eZ/sub 2/ ion. A comparison with some numerical results are presented. 15 refs.; 2 tabs.

21801 **(LBL—22470) Computational aspects of a non-cubic equation of state for phase-equilibrium calculations: Effect of density-dependent mixing rules.** Topliss, R.J.; Dimitrelis, D.; Prausnitz, J.M. (Lawrence Berkeley Lab., CA (USA); California Univ., Berkeley (USA). Dept. of Chemical Engineering). Sep 1986. Contract AC03-76SF00098. 11p. (CONF-870469—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004474.

From CEF 87: the use of computers in chemical engineering; Taormina, Sicily, Italy (26 Apr 1987).

An efficient procedure is presented for solving a non-cubic equation of state for density. In phase-equilibrium calculations, the costly computing step is not the density calculation but the calculation of the equation-of-state constants for the mixture. Illustrative calculations are given for high-pressure phase equilibria for hydrogen/ethane and methane/water. These calculations show the superiority of non-cubic equations with density-dependent mixing rules.

21802 **(UCRL—95452) Equations of state for the dynamic consolidation of powders.** Reaugh, J.E. (Lawrence Livermore National Lab., CA (USA)). 30 Jan 1987. Contract W-7405-ENG-48. 16p. (CONF-8611140—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006239.

From 4. conference on rapid solidification processing; Santa Barbara, CA, USA (14 Nov 1986).

Computer simulations of the dynamic consolidation of rapidly solidified powders require an equation of state (EOS) to describe the response of the consolidating powder mass. Various dynamic consolidation geometries are sensitive to different areas of the EOS surface. We discuss the EOS models that have proven satisfactory, and the important regions of those EOS surfaces. 18 refs., 11 figs., 1 tab.

21803 **Approximate solution to the scattering integral for general interatomic potentials.** Blanchard, J.P.; Ghoniem, N.M.; Chou, S.P. (Department of Mechanical, Aerospace, and Nuclear Engineering, University of California at Los Angeles, Los Angeles, California 90024). *Journal of Applied Physics;* **61**: No. 8, 3120-3123(15 Apr 1987).

An approximation of the scattering integral is derived by expanding the potential about the distance of closest approach and truncating the expansion so that the integral can be performed analytically. The results are improved by using the approximate integrand only in the region near the closest approach, and assuming zero potential for large distances. The analytical solution, which requires little computation time relative to other solution methods, is shown to yield sufficient accuracy for a wide range of particle energies and impact parameters, using both the Moliere and "Universal" potentials.

21804 **Direct and inverse scattering for viscoelastic media.** Ammicht, E.; Corones, J.P.; Krueger, R.J. (Applied Mathematical Sciences, Ames Laboratory-USDOE, Iowa State University, Ames, Iowa 50011). *Journal of the Acoustical Society of America;* **81**: No. 4, 827-834(Apr 1987).

A time domain approach to direct and inverse scattering problems for one-dimensional viscoelastic media is presented. Such media can be characterized as having a constitutive relation between stress and strain which involves the past history of the strain through a memory function, the relaxation modulus. In the approach in this article, the relaxation modulus of a material is shown to be related to the reflection properties of the material. This relation provides a constructive algorithm for direct and inverse scattering problems. A numerical implementation of this algorithm is tested on several problems involving realistic relaxation moduli.

21805 **Phase organization.** Tang, C.; Wiesenfeld, K.; Bak, P.; Coppersmith, S.; Littlewood, P. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). *Physical Review Letters;* **58**: No. 12, 1161-1164(23 Mar 1987). Contract AC02-76CH00016.

We describe the selection mechanism for novel pattern formation in a driven chain of nonlinear oscillators. Phase organization arises as a consequence of dynamical selection of minimally stable states.

**21806 Group theoretical basis of some identities for the generalized hypergeometric series.** Beyer, W.A.; Louck, J.D.; Stein, P.R. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Mathematical Physics (New York);* **28**: No. 3, 497-508(Mar 1987). Contract W-7405-ENG-36.

It is shown that Thomae's identity between two ${}_3F_2$ hypergeometric series of unit argument together with the trivial invariance under separate permutations of numerator and denominator parameters implies that the symmetric group $S_6$ is an invariance group of this series. A similar result is proved for the terminating Saalschuetzian ${}_4F_3$ series, where $S_6$ is shown to be the invariance group of this series (or $S_5$ if one parameter is eliminated by using the Saalschuetz condition). Here Bailey's identity is realized as a permutation of appropriately defined parameters. Finally, the set of three-term relations between ${}_3F_2$ series of unit argument discovered by Thomae [J. Thomae, J. Reine Angew. Math. 87, 26 (1879)] and systematized by Whipple [F. J. Whipple, Proc. London Math. Soc. 23, 104 (1925)] is shown to be transformed into itself under the action of the group $S_6 \times \Lambda$, where $\Lambda$ is a two-element group. The 12 left cosets of $S_6 \times \Lambda$ with respect to the invariance group $S_5$ are the structural elements underlying the three-term relations. The symbol manipulator m-smcapsa-smcapsc-smcapss-smcapsy-smcapsm-smcapsa-smcaps was used to obtain preliminary results.

**21807 Numerical evaluation of path-integral solutions to Fokker-Planck equations. III. Time and functionally dependent coefficients.** Wehner, M.F.; Wolfer, W.G. (Lawrence Livermore National Laboratory, University of California, P.O. Box 5508, Livermore, California 94550). *Physical Review [Section] A: General Physics;* **35**: No. 4, 1795-1801(15 Feb 1987).

A path-integral solution to truly nonlinear Fokker-Planck equations is derived. Such equations exhibit in the drift and diffusion coefficients a functional dependence on the distribution function. This type of implicit time dependence is shown to introduce terms into the propagator function of the exact same order in the time step tau, as does an explicit time dependence if the functional dependence is sufficiently smooth. A standard discrete lattice formulation of the path integral is then used to reproduce the appropriate, truly nonlinear Fokker-Planck equation. This discrete formulation provides a basis for an efficient numerical algorithm and is applied with excellent results to several example problems where exact solutions can be calculated.

**21808 Diffusion of magnetic fields into conductors of nonuniform resistivity.** Sprott, J.C. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). *Journal of Applied Physics;* **61**: No. 3, 817-821(1 Feb 1987).

Solutions are obtained for the spatial variation of electrical resistivity of cylindrical and rectangular conductors such that the magnetic field external to the conductor maintains a constant spatial variation as the magnetic field diffuses into the conductor. Practical implementations of the ideal solution are described.

**21809 Second-quantized molecular time scale generalized Langevin equation theory: Boson equivalent chain.** McDowell, H.K. (CLS-2 MS G738, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Chemical Physics;* **86**: No. 3, 1497-1508(1 Feb 1987).

A second-quantized version of molecular time scale generalized Langevin equation theory is developed in an equivalent chain format for quantum boson systems. The approach allows for nonlinear Hamiltonians and strong coupling to the bath. A bath average is defined which permits reduced dynamics prescriptions to be developed. The bath average is shown to be consistent with the notion that perturbations of a primary zone should damp away at long time.

**21810 Basis set methods for describing the quantum mechanics of a "system" interacting with a harmonic bath.** Makri, N.; Miller, W.H. (Department of Chemistry, University of California, and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Journal of Chemical Physics;* **86**: No. 3, 1451-1457(1 Feb 1987).

The case of a system (e.g., a one-dimensional reaction coordinate) coupled to a "bath" of many harmonic oscillators is treated by quantum mechanical basis set methods. By choosing the basis set for the bath to incorporate the coupling explicitly, it is shown how the bath can then be eliminated to obtain an effective Hamiltonian matrix for only the system. Numerical calculations are carried out which show that, even in the zeroth version of the approach, the effect on the system (e.g., the tunneling splitting in a double-well potential)= of coupling to the bath is described well, even when the effect is extremely large.

**21811 Direct and inverse scattering in the time domain for a dissipative wave equation. III. Scattering operators in the presence of a phase velocity mismatch.** Kristensson, G.; Krueger, R.J. (Division of Electromagnetic Theory, Royal Institute of Technology, S-100 44 Stockholm, Sweden). *Journal of Mathematical Physics (New York);* **28**: No. 2, 360-370(Feb 1987).

The direct scattering problem for an inhomogeneous lossy medium is examined for the one-dimensional case in which the phase velocity profile is discontinuous at the boundaries of the medium. Scattering operators (or impulse responses) and propagation operators are defined and equations that govern their behavior are developed. Knowledge of the scattering kernels for one round trip in the medium implies that the scattering kernels can be determined on any time interval. Numerical examples are presented. It is also shown that this scattering problem is reducible to one in which there are no phase velocity mismatches. This reduction provides considerable numerical advantage in the solution of the direct scattering problem. The inverse problem is examined in a companion paper.

**21812 Finite-size scaling and correlation lengths for disordered systems.** Chayes, J.T.; Chayes, L.; Fisher, D.S.; Spencer, T. (Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, New York 14853). *Physical Review Letters;* **57**: No. 24, 2999-3002(15 Dec 1986).

For a large class of d-dimensional disordered systems, we prove that if an appropriately defined finite-size scaling correlation length diverges at a nontrivial value of the disorder with an exponent $\nu$, then $\nu$ must satisfy the bound $\nu \geq 2/d$. Given the assumption that such a correlation length can be defined, the result applies to, e.g., percolation, disordered magnets, and Anderson localization, both with and without interactions. For localization, this puts stringent constraints on scaling theories and interpretation of experiments.

**21813 Devil's staircase.** Bak, P. (Brookhaven National Laboratory, Upton, New York). *Physics Today;* **39**: No. 12, 38-45(Dec 1986). Contract AC02-76CH00016.

When the interaction between an oscillator and its driver is strong enough, the oscillator will resonate at, or "lock" onto, an infinity of driving frequencies, giving rise to steps with a fractal dimension between 0 and 1.

**21814 Quantum distribution functions in nonequilibrium statistical mechanics.** O'Connell, R.F. (Louisiana State Univ., Baton Rouge, LA). pp 83-95 of Frontiers of nonequilibrium statistical physics. Moore, G.T.; Scully, M.O. New York, NY; Plenum Press (1986). (CONF-8406194—).

From NATO advanced study institute on nonequilibrium quantum statistical mechanics; Santa Fe, NM, USA (3 Jun 1984).

This paper concentrates on the inter-relationships between some of the more commonly used quantum distribution functions. For simplicity, a one-dimensional system in a pure state is represented since the case of a mixture in multi-dimensions presents no essential complications. This paper is concerned with the Wigner distribution function. The Cahill-Glauber class of generalized distribution functions are examined. A new class of generalized distribution functions is also presented.

21815 **Reduction of the wavepacket: how long does it take?.** Zurek, W.H. (Los Alamos National Lab., Los Alamos, NM). pp 145-149 of Frontiers of nonequilibrium statistical physics. Moore, G.T.; Scully, M.O. New York, NY; Plenum Press (1986). (CONF-8406194—).

From NATO advanced study institute on nonequilibrium quantum statistical mechanics; Santa Fe, NM, USA (3 Jun 1984).

This paper shows that the reduction of the wavepacket caused by the interaction with the environment occurs on a timescale which is typically many orders of magnitude shorter than the relaxation timescale tau. In particular, it is shown that in a system interacting with a canonic heat bath of harmonic oscillators decorrelation timescale of two pieces of the wavepacket separated by N thermal de Broglie wavelengths is approximately tau/$N^2$. Therefore, in the classical limit h to 0, dynamical reversibility (tau to $\infty$) is compatible with instantaneous coherence loss.

21816 **Maxwell's demon, Szilard's engine and quantum measurements.** Zorek, W.H. (Los Alamos National Lab., Los Alamos, NM). pp 151-161 of Frontiers of nonequilibrium statistical physics. Moore, G.T.; Scully, M.O. New York, NY; Plenum Press (1986). (CONF-8406194—).

From NATO advanced study institute on nonequilibrium quantum statistical mechanics; Santa Fe, NM, USA (3 Jun 1984).

The author proposes and analyzes a quantum version of Szilard's one-molecule engine. In particular, the author recovers, in the quantum context, Szilard's conclusion concerning the free energy "cost" of measurements (delta /sub F/ is greater than or equal to k/sub b/T1n2) per bit of information. A cycle of Szilard's engine is illustrated for both the original and quantum versions. The measurement of the location of the molecule is essential in the process of extracting work in both classical and quantum design. Measurements are made by the classical Maxwell's demon.

21817 **What are squeezed states really like?.** Nieto, M.M. (Los Alamos National Lab., Los Alamos, NM). pp 287-307 of Frontiers of nonequilibrium statistical physics. Moore, G.T.; Scully, M.O. New York, NY; Plenum Press (1986). (CONF-8406194—).

From NATO advanced study institute on nonequilibrium quantum statistical mechanics; Santa Fe, NM, USA (3 Jun 1984).

This paper discusses the simple harmonic oscillator, quantum mechanics and squeezed (coherent) states. The coherent states are discussed from the Schrodinger point of view and from the operator formalism. The author explains that a squeezed state is a slight relaxation; the relaxation is simply that one allows the width of the Gaussian to be different from that of the ground state. It, too, can be displaced and the wave packet will follow the classical motion in time. The mathematical properties of squeezed states are also reviewed in this paper.

21818 **Manifold and supermanifold: global aspects of supermanifold theory.** Rabin, J.M. (Enrico Fermi Institute, Univ. of Chicago, Chicago, IL). pp 169-176 of Topological properties and global structure of space-time. Bergmann, P.G.; De Sabbata, V. New York, NY; Plenum Press (1986). (CONF-8505317—).

From NATO advanced study institute on topological properties and global structure of space-time; Erice, Italy (12 May 1985).

The author reviews the basic definitions of the manifold and supermanifold and describes the foliated structure of a general supermanifold which replaces the vector bundle structure of the DeWitt case. Some examples are given of supermanifolds with nontrivial topology in the Grassmann directions. It is shown how an integral can be defined on supermanifolds far more general than the conventional vector bundles. The author speculates on the new physics which may be contained in supergravity or superstring theories defined on topologically exotic supermanifolds.

21819 **Singular values and condition numbers of galerkin matrices arising from linear integral equations of the first kind.** Allen, R.C. Jr.; Boland, W.R.; Faber, V.; Wing, G.M. (Univ. of New Mexico, Albuquerque). *Journal of Mathematical Analysis and Applications;* **109**: No. 2, 564-590(1 Aug 1985).

In [1] the problem of the conditioning of matrices arising in the numerical solution of integral equations of the first kind by Galerkin and collocation schemes was investigated. A lower bound on the matrix condition number was found and its behavior as a function of the smoothness of the kernel of the original equation was studied. Some numerical results presented in [1] and much more extensive studies reported in [2] served to demonstrate the validity and usefulness of the theory. In these studies all basis functions were required to be orthonormal. Current computational methods frequently use non-orthonormal bases (for example, splines), and the question naturally arises as to whether such bases yield better conditions. Actually, in both [1] and [2] piecewise constant splines were examined as a special orthonormal set. They, of course, conformed to the general analytical theory. Computationally they usually proved more satisfactory than more classical orthonormal bases, providing both better conditioning and more satisfactory numerical results. In this paper the authors shall examine much more general bases including some that are spline-like. They show that in general little change is made in the analytical results found in [1]. They also provide several corroborating numerical examples.

21820 **Fractional statistics and fractional quantized Hall effect.** Tao, R.; Wu, Y.S. (Univ. of Washington, Seattle). *Physical Review [Section] B: Solid State;* **31**: No. 10, 6859-6860(15 May 1985). Contract AC06-81ER40048.

The authors suggest that the origin of the odd-denominator rule observed in the fractional quantized Hall effect (FQHE) may lie in fractional statistics which govern quasiparticles in FQHE. A theorem concerning statistics of clusters of quasiparticles implies that fractional statistics do not allow coexistence of a large number of quasiparticles at fillings with an even denominator. Thus, no Hall plateau can be formed at these fillings, regardless of the presence of an energy gap. 15 references.

21821 **Comment on effects of relative energy contributions in a two-interaction transition.** Cahn, R.N.; Jackson, J.D. (Lawrence Berkeley Lab., CA). *Physical Review Letters;* **54**: No. 12, 1329-1330(25 Mar 1985).

In a comment on a paper by Reiss, the authors review quantum mechanical results on dipole transitions. They conclude that the transitions do not depend on the form of the potential energy used in the calculations. A reply by Reiss follows which invokes leptonic currents to explain his original position.

21822 **Probability densities and the radon variable transformation theorem.** Ramshaw, J.D. (Los Alamos National Lab., NM). *American Journal of Physics;* **53**: No. 2, 178-179(Feb 1985).

D. T. Gillespie recently derived a random variable transformation theorem relating to the joint probability densities of functionally dependent sets of random variables. The present author points out that the theorem can be derived as an immediate corollary of a simpler and more fundamental relation. In this relation the probability density is represented as a delta function averaged over an unspecified distribution of unspecified internal random variables. The random variable transformation is derived from this relation.

21823 (JINR—D-17-84-850-Vol.2, pp 138-151) **Ising models and soliton equations.** Perk, J.H.H.; Au-Yang, H. (State Univ. of New York, Stony Brook, USA). 1985. NTIS (US Sales Only), PC A16/MF A01. File Number DE87780102. (CONF-8408213—Vol.2).

From 3. international symposium on selected topics in statistical mechanics; Dubna, USSR (22 Aug 1984).

Several new results for the critical point of correlation functions of the Hirota equation are derived within the two-dimensional Ising model. The recent success of the conformal-invariance approach in the determination of a critical two-spin correration function is analyzed. The two-spin correlation function is predicted to be rotationally invariant and to decay with a power law in this approach. In the approach suggested here systematic corrections due to the underlying lattice breaking the rotational invariance are obtained.

21824 (JINR—D-17-84-850-Vol.2, pp 211-223) **Quantization of vortices in /sup 4/He and lambda-transition.** Rasetti, M. (Politecnico di Torino, Italy; Istituto Nazionale di Fisica Nucleare, Turin, Italy). 1985. NTIS (US Sales Only), PC A16/MF A01. File Number DE87780102. (CONF-8408213—Vol.2).

From 3. international symposium on selected topics in statistical mechanics; Dubna, USSR (22 Aug 1984).

An attempt to give a theoretical explanation of the Λ -transition in liquid /sup 4/He is made in terms of quantum statistical mechanics. A canonical quantization scheme is developed for vortices in superfluid He 2, taking as a starting point the classical Thompson theory of vortices. The next step is made for realizing that the structure of a current algebra A and of the corresponding group generate a space of configurations which is more similar to a set of planar Jordan curves, than to a set of three-dimensional loops. Such unexpected feature stems out of the explicit construction of a complete set of commuting observables from the generators of the algebra A. The final step of the theory is computing the grand-canonical partition function.

21825 (JINR—D-17-84-850-Vol.2, pp 239-250) **Canonical transformations in problems of quantum statistical mechanics.** Sankovich, D.P. (AN SSSR, Leningrad. Matematicheskij Inst.). 1985. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE87780102. (CONF-8408213—Vol.2).

From 3. international symposium on selected topics in statistical mechanics; Dubna, USSR (22 Aug 1984).

The problem of general canonical transformations in quantum systems possessing a classical analog is considered. The main role plays the Weyl representation of dynamic variables of the quantum system considered. One managed to build a general diagram of canonical transformations in a quantum case and to develop a method for reducing one or another operator to the simplest canonical form. In this case the procedure, being analogous to the Poincare-Birkhof normalization based on the Lie series theory, occurs.

21826 (JINR—D-17-84-850-Vol.2, pp 269-275) **On some exact results for model systems, interacting with boson field.** Turaev, M.T. (AN Uzbekskoj SSR, Tashkent. Inst. Yadernoj Fiziki). 1985. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE87780102. (CONF-8408213—Vol.2).

From 3. international symposium on selected topics in statistical mechanics; Dubna, USSR (22 Aug 1984).

A new approach to the solution of problems on quantum statistical mechanics, in particular to the investigation of model dynamic problems by the exact mathematical methods, is suggested. Model systems interacting with a boson field are solved by the method of approximating hamiltonians. A series of asymptotically exact relations for correlation averages is built without using some relations for free energies. For some models correlation averages characterize a long-range order in the subsystem (polarization, magnetization, a slit in the spectrum of elementary excitations in the theory of superconductivity). Correlations for phase transformations, accompanying by compensating macroscopic occupation of boson modes, are presented. Estimations (upper and lower) for free energy are given).

21827 (JINR—D-17-84-850-Vol.2, pp 310-321) **Renormalization group and functional self-similarity in various fields of physics.** Shirkov, D.V. 1985. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE87780102. (CONF-8408213—Vol.2).

From 3. international symposium on selected topics in statistical mechanics; Dubna, USSR (22 Aug 1984).

Difference between physical principles of renormalization group transformations in the systems with the infinitely great number of degree of freedom and functional self-similarity of simple physical systems is discussed. Transformations of functional self-similarity in a general form are introduced. The relation between functional and usual self-similary is established. Coincidence between a complex construction of the Kadanoff-type, lying in the basis of a renormgroup of the critical phenomenon theory, and the more obvious property of symmetry leading to functional self-similarity of simple dynamical systems.

21828 (JINR—D-17-84-850-Vol.2, pp 7-35) **Relativistic gravitation theory.** Logunov, A.A.; Mestvirishvili, M.A. (Moskovskij Gosudarstvennyj Univ., USSR). 1985. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE87780102. (CONF-8408213—Vol.2).

From 3. international symposium on selected topics in statistical mechanics; Dubna, USSR (22 Aug 1984).

The relativistic gravitation theory within the framework of a special principle of relativity is built. Conservation laws for energy-momentum and angular momentum are stricktly fulfilled and have a covariant character. The authors built effective field Riemann space, not escaping the Minkowski space by means of a tensor gravitational field and a geometrization principle. Construction has a field nature, as the effective strength space is created by the gravitational field of the Faraday-Maxwell type. It is possible to conserve the Hilbert-Einshtein equation complementing their by four field equations, according to which the gravitational field possesses only spin 2 and 0 in the general case.

21829 (JINR—D-17-84-850-Vol.2, pp 236-238) **Two-dimensional nonlinear equations of supersymmetric gauge theories.** Savel'ev, M.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. NTIS (US Sales Only), PC A16/MF A01. File Number DE87780102. (CONF-8408213—Vol.2).

From 3. international symposium on selected topics in statistical mechanics; Dubna, USSR (22 Aug 1984).

Supersymmetric generalization of two-dimensional nonlinear dynamical equations of gauge theories is presented. The nontrivial dynamics of a physical system in the supersymmetry and supergravity theories for (2+2)-dimensions is described by the integrable embeddings of Vsub(2/2) superspace into the flat enveloping superspace Rsub(N/M), supplied with the structure of a Lie superalgebra. An equation is derived which describes a supersymmetric generalization of the two-dimensional Toda lattice. It contains both super-Liouville and Sinh-Gordon equations.

21830 **Integrating some infinite oscillating tails.** Lyness, J.N. (Argonne National Lab., IL). *Journal of Computational and Applied Mathematics;* **12-13**: 109-117(1985). Contract W-31-109-ENG-38.

The numerical evaluation of integrals of f(x) where f(x) is slowly decaying and oscillating in sign is considered. A method, proposed originally by Longman has been modified, and can be used effectively when certain analytic information about the tail of f(x) is available. Specifically one requires that the distance between successive zeros tends to a finite limit whose numerical value is available. Examples include $f(x) = g(x)\, j(x)$ where j(x) is a circular function or a Bessel function and g(x) is ultimately positive. A series acceleration technique, which is very closely related to the Euler transformation is introduced, and shown by example to be useful in summing an oscillating series. Longman's method, which applies this transformation to a sequence, each member of which is obtained by numerical integration over an arch of the integrand function is described. A simple modification of Longman's method which seems to make it easier to use without compromising its effectiveness is given. The modified method is discussed from the point of view of increasing the reliability when results of specified accuracy are required.

21831 **(JINR—D-17-84-850-Vol.2) 3. International symposium on selected topics in statistical mechanics. Vol. 2.** (Joint Inst. for Nuclear Research, Dubna (USSR); AN SSSR, Leningrad. Matematicheskij Inst.). 1985. 368p. (CONF-8408213—Vol.2). NTIS (US Sales Only), PC A16/MF A01. File Number DE87780102.

From 3. international symposium on selected topics in statistical mechanics; Dubna, USSR (22 Aug 1984).

Separate abstracts were prepared for 10 papers in these proceedings. (DWL)

**21832 Extended moment series and the parameters of the negative binomial distribution.** Bowman, K.O. (Union Carbide Corp., Oak Ridge, TN). *Biometrics;* **40**: 289-252(Mar 1984). Contract W-7405-ENG-26.

Recent studies indicate that, for finite sample sizes, moment estimators may be superior to maximum likelihood estimators in some regions of parameter space. In this paper a statistic based on the central moment of the sample is expanded in a Taylor series using 24 derivatives and many more terms than previous expansions. A summary algorithm is required to find meaningful approximants using the higher-order coefficients. A example is presented and a comparison between theoretical assessment and simulation results is made.

**21833 Accidental degeneracies, hidden supersymmetries, and spectrum-generating superalgebras.** Balantekin, A.B. (Physics Div., Oak Ridge National Lab., Oak Ridge, TN 37831). pp 616-620 of International symposium on nuclear shell models. Vallieres, M.; Wildenthal, B.H. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8410144—). Contract AC05-84OR21400.

From International symposium on nuclear shell model; Philadelphia, PA, USA (31 Oct 1984).

Recently, several Hamiltonians appeared in the literature which exhibit degeneracies that do not seem to be explainable in terms of hidden symmetry groups. Such Hamiltonians are shown to constitute supersymmetric quantum-mechanical systems. The concept of spectrum-generating superalgebras is introduced and coordinate space representations of the relevant non-compact superalgebras Osp(1/2) and SU(1,1/1) are exhibited.

**21834 Limiter of critical exponent university.** Baker, G.A. Jr. (Los Alamos National Lab., NM). *Journal of Physics A: Mathematical and General;* **17**: L621-L626(1984).

The authors show that in three dimensions the consideration of single-spin distributions containing a factor of $\exp(\lambda s^6)$ can lead to statistical mechanical models of dramatically different character from those defined by the usual field theory picture of the renormalization group theory of critical phenomena. These models plainly fall outside the usual, and previously expected, universality class. 21 references.

**21835 Parallel first-order method for parabolic.** Rodrigue, G. (Lawrence Livermore National Lab., CA). pp 329-342 of High-Speed Computation. Kowalik, J.S. (ed.). Berlin, West Germany; Springer-Verlag (1984). Contract W-7405-ENG-48.

In this paper, it is shown how computing architectures have affected the direction of research in deriving numerical time - differencing schemes for parabolic partial differential equations. In particular, the problem of solving the two-dimensional diffusion equation is considered.

**21836 Frame on frames: an annotated bibliography.** Wright, T.; Tsao, H.J. (Oak Ridge National Lab., TN). pp 25-72 of Statistical methods and the improvement of data quality. Orlando, FL; Academic Press, Inc. (1983).

The success or failure of any sample survey of a finite population is largely dependent upon the condition and adequacy of the list or frame from which the probability sample is selected. Much of the published survey sampling related work has focused on the measurement of sampling errors and, more recently, on nonsampling errors to a lesser extent. Recent studies on data quality for various types of data collection systems have revealed that the extent of the nonsampling errors far exceeds that of the sampling errors in many cases. While much of this nonsampling error, which is difficult to measure, can be attributed to poor frames, relatively little effort or theoretical work has focused on this contribution to total error. The objective of this paper is to present an annotated bibliography on frames with the hope that it will bring together, for experimenters, a number of suggestions for action when sampling from imperfect frames and that more attention will be given to this area of survey methods research.

# 70 FUSION ENERGY

*REFER ALSO TO CITATION(S) 21290, 21616, 22069*

**21837 (EUR-CEA-FC-RA—1985) 1985. Progress annual report.** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). Jun 1986. 100p. (In French). NTIS (US Sales Only), PC A05/MF A01. File Number DE87751053.

Tore Supra construction has been vigorously continued. The whole cryogenic system has been entirely delivered. On TFR priority has been given to electron cyclotron resonance heating; but also neutral heating mechanisms, pellet injection, plasma-wall interaction in the presence of pumped limiter, impurity transport and plasma turbulence have been studied and progress on diagnostics have been made. On Petula, with lower hybrid wave, the numerous results on ion heating, current drive, plasma stability in the presence of non-inductive current and on Tore Supra technical problems are important. At last, theoretical and numerical results are concerned with plasma equilibrium macroscopic evolution of plasma, RF heating, plasma instabilities, magnetic islands, turbulence, transport coefficients and spectroscopy.

**21838 Conference record of the 1984 IEEE international conference on plasma science.** Piscataway, NJ; IEEE Service Center (1984). 128p. (CONF-840513—). IEEE Service Center, 445 Hoes Ln., Piscataway, NJ 08854.

From IEEE international conference on plasma science; St. Louis, MO, USA (14 May 1984).

These proceedings include papers on all aspects of plasma science. Papers are grouped under the headings of: 1.) Intense Electron and Ion Beams; 2.) Tokamaks and Stellators; 3.) Fast Opening Switches; 4.) Toroids and Pinches; 5.) Neutral Beams for Fusion Research; 6.) Gaseous Electronics; 7.) High Power Microwave Generation; 8.) Fusion Technology and MHD; 9.) Nuclear Pumped Lasers; 10.) Intense Electron and Ion Beams; 11.) Mirrors and EBT; 12.) Plasma Heating and Current Drive; 13.) Ion Beams and Mass Accelerators; 14.) Plasma Diagnostics; 15.) Plasma Waves, Instabilities, and Antennas; 16.) Laser Plasma Interactions and ICF; 17.) Plasma Focus; 18.) Computer Methods.

## 7001 Plasma Research

*REFER ALSO TO CITATION(S) 20854, 21040, 21443, 21996, 21999, 22007, 22033, 22036, 22037, 22037, 22038, 22040*

**21839 (DOE/ER/51030—T2) A program to develop advanced EBT [ELMO Bumpy Torus] concepts and international collaboration on the Bumpy Torus concept: Final report.** (Applied Microwave Plasma Concepts, Inc., Encinitas, CA (USA)). 14 Jan 1987. Contract AC03-82ER51030. 170p. (AMPC—14-023). NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE87004602.

This project was undertaken to develop innovative concepts for improving the performance of ELMO Bumpy Torus devices in those aspects of plasma confinement that are particularly relevant to an eventual EBT reactor concept. These include effective magnetic utilization using Andreoletti coils, enhanced confinement using positive ambipolar potentials, and attractive divertor concepts that are compatible with formation and maintenance of ELMO rings. Each of the three major objectives was achieved and, except for the divertor studies, documented for publication and presentation at major scientific meetings. This report provides a brief recapitulation of the major results achieved in the form of a collection of those publications, together with this Introduction.

**21840 (DOE/ER/53122—3) Plasma diagnosis by dye laser intracavity absorption: Final report for period January 1, 1982-May 31, 1986.** Brink, G.O. (State Univ. of New York, Buffalo (USA)). May 1986. Contract AC02-81ER53122. 28p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006407.

Dye laser intracavity absorption (ICA) has been studied as a potential diagnostic for plasma or neutral beam systems. For magnetic field measurements it is necessary to make Zeeman effect measurements on the resonance transition of atomic lithium on a millisecond time scale, or to make motional Stark Effect measurements on an injected fast atomic beam of hydrogen. To do this it may be necessary to sweep the dye laser in wavelength at a rapid rate so that the absorber can be sampled many times during the measurement. We have examined both of these possibilities during this contract. A rather detailed absorption spectrum of molecular hydrogen and deuterium arising in the 2c $^3$Piu and other electronic states has been obtained and analyzed. This has provided new information on the types of molecular species that may be detected in a plasma by ICA, and may provide a basis for the application of ICA for the diagnosis of the edge plasma in a tokamak or in the end regions of a mirror machine.

21841 **(DOE/ER/53201—T1) Unified theory of ripple transport in stellarators.** Beidler, C.D.; Hitchon, W.N.G.; van Rij, W.I.; Hirshman, S.P.; Shohet, J.L. (Wisconsin Univ., Madison (USA). Torsatron/Stellarator Lab.). Dec 1986. Contract FG02-85ER53201;AC05-84OR21400;FG02-86ER43216. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87004900.

The distribution function for ripple trapped particles has been found in a series form valid for all low collision frequencies, for standard and transport-optimized stellarators. The diffusion coefficient obtained using this distribution function shows excellent agreement with the results of Monte Carlo and Fokker-Planck computer codes, in the cases studied.

21842 **(DOE/ER/53206—7) Theoretical studies of the heating of toroidal plasmas with radiofrequency electromagnetic radiation: Progress report, July 1, 1986-June 30, 1987.** Swanson, D.G.; Wersinger, J.M.; Hanson, J.D. (Auburn Univ., AL (USA). Dept. of Physics). Feb 1987. Contract FG05-85ER53206. 29p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006335.

Progress is reported in several areas of interest to rf heating of plasmas. (1) The development of the complex ray-tracing code is largely implemented. The complex focussing terms are nearing completion. This allows the following of rays through regions where normal ray-tracing methods fail. (2) A major contribution is in the area of parametric instabilities, and a way to minimize their effect on the lower hybrid waves. By following a bundle of rays and evaluating the growth rate for the most rapidly growing waves at each point, the daughter waves have been followed to the point where pump depletion begins to be important. It is found that pump depletion is a serious problem for lower hybrid rays in typical plasmas, but its effect can be diminished in some cases by frequency modulation. (3) The continuing study of mode conversion problems has taken several directions. It has been shown that ion absorption of lower hybrid rays frequently involves cases where three types of waves are coupled through linear mode conversion in the same region of space, namely the cold lower hybrid wave, the warm lower hybrid wave, and an ion Bernstein mode. This three wave coupling problem is analyzed analytically in terms of a sixth order wave equation which describes coupling between all branches, and an analytical model may now adequately represent the physical problem. The formal solution of this equation verifies the major expectations of the analysis, and gives analytic coupling coefficients for the case with no damping. Finally, the exact order reduction method has been developed to the extent where numerical methods need to be introduced. The analytic evaluation of the form of the Green function is completed, and numerical implementation will begin before the end of the current contracting period and continue through the extended renewal period.

21843 **(DOE/ER/53219—1) Analysis of the effects of impurity buildup on the performance of a reversed field pinch: Final report.** Klevans, E.H. (Pennsylvania State Univ., University Park (USA)). 30 Oct 1986. Contract FG02-86ER53219. 42p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005438.

A Zero-Dimensional code has been developed and used for parametric studies of ZT-40M behavior and the projected behavior of CPRF(ZT-H). The code includes equations for energy balance for electrons and ions. Particle density and current are specified quantities. Impurities are treated using a coronal equilibrium model. The energy confinement times for electrons and ions are permitted through the use of multiplicative coefficients. Ohmic heating includes an anomaly factor, and an experimentally observed ion heating is modeled by use of a multiplicative factor times Ohmic heating. The data from ZT-40M is used to obtain a "reasonable" set of coefficients, and the effect on T/sub e/ and T/sub i/ of varying these coefficients is examined. Various levels and kinds of impurities are introduced and their effects are examined. Both flat top and ramp current waveforms are studied. The results are then applied to study a ramp startup of CPRF for a current level of 1 MA.

21844 **(DOE/ET/53047—25) Confinement and heating of high beta plasmas with emphasis on compact toroids: Task 2, Stellarator and heliac research: Annual report, October 1, 1985-September 30, 1986.** Ribe, F.L. (Washington Univ., Seattle (USA). Dept. of Nuclear Engineering). 31 Dec 1986. Contract AT06-72ET53047. 63p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87005554.

Progress over the past year has enabled us to complete the comprehensive experimental investigation of the equilibrium and stability of the linear heliac and the linear l = 1 stellarator configration. In the case of the heliac work, we discoverd axisymmetric hot plasma near the axial conductor ("hardcore") in amounts which are comparable to the helically symmetric hot plasma centered on the magnetic axis. From this result came the motivation for an extended investigation which concentrates on the details of high-beta heliac formation. Important first results of the formation study have been obtained. In the case of the stellarator work, we have observed the flute-like m = 1 instability foe a specific set of experimental parameters and, for a different set, we have observed the mode stabilized by the combined effects of a finite ion Larmor radius and a nearby conducting wall. The single-discharge CV ion-temperature diagnostic system has been debugged and has yielded a heliac temperature measurement of (90 +- 10)eV. The plasma density diagnostic system based on cross-tube interferometry has been modified from its previous design for use with the somewhat wrinkly helical discharge tube.

21845 **(DOE/ET/53088—264) Kelvin-Helmholtz instability and vortices in magnetized plasma.** Horton, W.; Tajima, T.; Kamimura, T. (Texas Univ., Austin (USA). Inst. for Fusion Studies; Nagoya Univ. (Japan). Inst. of Plasma Physics). Dec 1986. Contract FG05-80ET53088. 36p. (IFSR—264). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005522.

Analytic theory and implicit particle simulations are used to describe the evolution of the Kelvin-Helmholtz instability and the plasma vortices driven by a nonuniform E x B flow velocity. Formulas for plasma convection arising from the self-consistent plasma electric field give the rate of anomalous momentum transport across the magnetic field. The momentum transport is shown to be controlled by the tilting angle of the elliptical vortex with respect to the direction of the parallel flow. Three stages of evolution are investigated and formulas for the final vortex state are given.

21846 **(DOE/ET/53088—269) Dissipative trapped particle modes in tandem mirrors.** Berk, H.L.; Chen, C.Y. (Texas Univ., Austin (USA). Inst. for Fusion Studies). Jan 1987. Contract FG05-80ET53088. 41p. (IFSR—269). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006344.

The theory for the dissipative trapped particle modes is developed for a tandem mirror taking into account equilibrium rotational effects, electron temperature gradients and an axial ambipolar potential, for a broad range of collisional parameters. The electrons are treated as a Maxwellian plasma that occupies the central cell and anchor cell regions. It is assumed that the eigenfunction is piecewise constant with abrupt transitions between the anchor and central cell regions. It is found that when $\omega/nu/sub\ p/ \geq 1$, with $\omega$ the mode frequency nu/sub p/ the Pastukhov loss rate, that the energy conservation structure of the collision operator produces important changes to previously developed theories. A solution to the problem is achieved by using the solution for the lifetime of an

electron in an ambipolar trap, taking into account the global energy conservation. The energy conservation structure also allows a self-consistent description of dissipative instabilities when thermal gradient and electric fields are present. At very high collision frequency, a new dispersion relation is obtained, which exhibits an axially rotational shear drive coupled to radial temperature gradients producing instability. Numerical studies are presented for some parameters, with the deviation from previous theory highlighted.

21847 **(EUR-CEA-FC—1286) Plasma current profile monitoring with hybrid wave.** Briffod, G. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). Sep 1985. 14p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751044.

Recent experiments of plasma heating on Jet and TFTR have shown results which confirm that current and electronic temperature profiles are tightly correlated. To modify the energy contents at plasma current given, the current profile J(r) must then be modified and its value J(o) on the axis controlled. A control method of it with hybrid wave is proposed in this report.

21848 **(EUR-CEA-FC—1289) Analysis of soft X-ray spectra got with a lithium-silicon detector. Comparison with computed shapes of electron distribution function with and without electron cyclotron heating.** Jacquet, L.; Pain, M.; Dubois, M.A.; Pecquet, A.L. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). May 1986. 12p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751045.

The study of the suprathermal part of the electron distribution function is very important for comprehension of current drive phenomenon and more generally of fast particle confinement. A numerical code has been developed allowing the electron distribution function calculation. It has been faced to experiment through soft X-ray spectra analysis. Measurements have been made on TFR Tokamak with and without electron cyclotron heating.

21849 **(EUR-CEA-FC—1291) Analysis of ion cyclotron minority heating regime in Tokamaks.** Cotsaftis, M.; Wang, P.K.C. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). Feb 1986. 74p. NTIS (US Sales Only), PC A04/MF A01. File Number DE87751046.

Using an analytical representation of power fractions onto electrons and minority ions, a system reducing to lowest order to a O-D model has been established for ICRF heating of a Tokamak plasma in minority heating scheme. This system includes proper sources and sinks affecting in the KeV range the dynamics of temperatures and impurity production. It is mainly shown, due to the indirect nature of the heating and the variation of power fractions with temperatures, that the efficiency drops dramatically, almost independent of heat transport law, causing the majority ions temperature to decrease above an RF power input threshold. On the other hand, the system exhibits a branching structure above a critical density threshold, above which a disruptive behaviour sets in. Application to JET experiment gives good agreement with experimental observations, and typically a doubling of majority ions temperature from Joule heating at RF power threshold (2 keV average for 8-9 MW).

21850 **(EUR-CEA-FC—1292) Microfluctuations and energy diffusion in Tokamaks.** Gresillon, D.; Truc, A.; Olivain, J. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). Feb 1986. 29p. (In French). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751047.

It has been tried to show existence of structures (microfluctuations) at small scale in the plasma and an experimental relation between these fluctuations and the plasma confinement, measured elsewhere, has been researched. The plasma studied is the Fontenay-aux-Roses Tokamak plasma (TFR) and the observation mean of fluctuations is given by Thomson diffusion of an electromagnetic wave by plasma electrons. The plasma confinement is measured by energy balance method.

21851 **(EUR-CEA-FC—1294) Statistical analysis of Tokamak plasma turbulence.** Barkley, H.J.; Andreoletti, J.; Gervais, F.; Olivain, J.; Quemeneur, A.; Truc, A. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). Apr 1986. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751048.

Coherent $CO_2$ laser signals scattered from TFR Tokamak plasmas have been analysed by determining their correlation integrals. The results of this study indicate that the plasma turbulence appears as a dynamic system which contains a strange attractor with a correlation exponent between 2.4 and 2.8, but which requires a sufficiently rapid data acquisition rate in order to reveal any internal structure.

21852 (EUR-CEA-FC—1295, pp 29-32) **Density profile from microwave reflectometry and confinement properties of a lower hybrid current drive sustained tokamak discharge.** Ichtchenko, G.; Bottollier-Curtet, H.; Goniche, M. (Association EURATOM-CEA CEN Grenoble, 38, France. Dept de Recherches sur la Fusion Controlee). May 1986. NTIS (US Sales Only), PC A04/MF A01. File Number DE87751062. (CONF-860412—Pt.1).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Two millimeter wave reflectometers using the extraordinary mode of propagation, have been installed on Petula in order to investigate their potentialities for application to larger tokamaks. By sweeping the frequency range 75-110 GHz, it was possible to measure the central part of the density profile. The addition of a second reflectometer working in the range 60-90 GHz allowed the determination of the external part of the profile. The resulting profile is presented with and without L.H. current drive application. The effect of L.H. current drive application is particularly marked on the scrape-off layer plasma, whose density can be decreased by more than a factor of 2. It is generally observed that in these conditions of moderate RF level, the scrape-off density has the same temporal and parametric dependence than the loop voltage, but when the input RF power is further increased, this effects saturates while the loop voltage continue to decrease.

21853 (EUR-CEA-FC—1295, pp 33-36) **Attempt at MHD mode control by feedback modulation of L.H. driven current.** Parlange, F.; Vallet, J.C. (Association Euratom-CEA CEN Grenoble, 38, France. Dept de Recherches sur la Fusion Controlee). May 1986. NTIS (US Sales Only), PC A04/MF A01. File Number DE87751062. (CONF-860412—Pt.1).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

MHD activity in Tokamak discharges with lower hybrid current drive has distinct features which can be used to stabilize tearing modes. A way of reducing the m=2 tearing mode was recently proposed, consisting in driving more current at the 0 point of the islands than at the X point, by means of amplitude modulated lower hybrid waves. The way it was tested in Petula is presented here.

21854 (EUR-CEA-FC—1295, pp 41-44) **Power amplification factor on lower-hybrid waves driven tokamaks.** Tonon, G. (Association EURATOM-CEA CEN Grenoble, 38, France. Dept de Recherches sur la Fusion Controlee). May 1986. NTIS (US Sales Only), PC A04/MF A01. File Number DE87751062. (CONF-860412—Pt.1).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

As shown by many studies, a continuous operation is an attractive alternative for tokamaks. Up to now, only RF waves, for which frequency is close to the lower hybrid frequency have led to a significative efficiency up to electron densities around $10^{20}$ e.m$^{-3}$. For a continuous operation of a Tokamak, the circulating power must be not too large and consequently the plasma power amplifi-

cation factor Qsub(p) has to be high enough. According to a model which determines the current drive efficiency when we consider the injection of slow-waves on the torus, in good agreement with the results of recent current drive experiments, we have determined the Qsub(p) values achievable with this type of waves.

21855 (EUR-CEA-FC—1295, pp 45-48) **Lower hybrid current drive in the presence of a constant DC electric field on Petula-B.** Van Houtte, D.; Briffod, G.; Gormezano, C.; Panzarella, A.; Parlange, F. (Association EURATOM-CEA CEN Grenoble, 38, France). May 1986. NTIS (US Sales Only), PC A04/MF A01. File Number DE87751062. (CONF-860412—Pt.1).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

In present LHCD experiments, the research is directed towards a combined RF current drive and inductive current drive. This hybrid current drive appears to be the most promising method both to help the OH tranformer to save volt-second during higher plasma current ramp-up or longer plasma current flat top of the large tokamaks and to improve their plasma performances. For such hybrid discharges, an optimum operating mode is obtained on Petula-B at low RF power level in the presence of a DC electric field.

21856 **(EUR-CEA-FC—1295) Papers presented by the SIG at the 13. European conference on controlled fusion and plasma heating.** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). May 1986. 54p. (CONF-860412—Pt.1). NTIS (US Sales Only), PC A04/MF A01. File Number DE87751062.

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

In this report, papers gathered essentially around lower hybrid wave heating and current drive. Efficiency, saturation, conduction are studied; design studies are made for multijunction grill. Optimization of wave launching and absorption is researched. Lower hybrid current drive which is non-inductive current drive together with ohmic current is studied. At last suppression of sawtooth instabilities by current drive is also presented.

21857 (EUR-CEA-FC—1295, pp 1-12) **Review of lower hybrid wave heating and current drive.** Gormezano, C. (Association Euratom-CEA, 38 - Grenoble, France. Dept. de Recherches sur la Fusion Controlee). May 1986. NTIS (US Sales Only), PC A04/MF A01. File Number DE87751062. (CONF-860412—Pt.1).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Interaction of Lower Hybrid waves and plasmas is a very versatile method which has proven to be effective in a large range of applications: bulk ion heating, bulk electron heating, non inductive current drive. If the ratio between the mean velocity of HF induced fast particles and the thermal velocity of the bulk population is relatively small, effective bulk ion heating or bulk electron heating can occur via collisional transfer. If the above ratio is too large, fast ions, which have mainly a perpendicular energy, are poorly confined. Moreover they can be harmful for the discharge (impurities, etc...) since they are lost on the walls. In contrast, HF induced fast electrons gain essentially a parallel momentum from the wave. If unidirectional waves are launched, the dissymetry in electron distribution result in the obtention of an effective non inductive current.

21858 (EUR-CEA-FC—1295, pp 13-16) **Lower hybrid wave accessibility as a means for current profile control.** Briffod, G.; Gormezano, C.; Parlange, F.; Van Houtte, D. (Association EURATOM-CEA, 38 - Grenoble, France. Dept. de Recherches sur la Fusion Controlee). May 1986. NTIS (US Sales Only), PC A04/MF A01. File Number DE87751062. (CONF-860412—Pt.1).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Powerful ICRH experiments on JET and Neutral Beam Injection of various species on TFTR have recently confirmed the insensitivity of the temperature and safety factor profile shapes to the heating profile and the important role played by the sawtooth activity on the overall performances. In order to overcome these limitations, we propose in this paper, in a Tokamak operating at constant plasma current: to control the resistive part of the current by driving an H.F. current by Lower Hybrid Wave. To act on the current profile, with the constraint that $q(o) > 1$ by controlling the wave penetration. Constant plasma current Tokamak discharges in which a part of the current is driven by L.H.W. have been extensively studied on PETULA and this mode of operation has proven to be very efficient in stabilizing the sawtooth and M.H.D. activity.

21859 (EUR-CEA-FC—1295, pp 17-20) **Saturation and conduction studies in non-inductive Tokamak discharges via electron cyclotron emission radiation measurements.** Girard, A.; Rax, J.M. (Association EURATOM-CEA, CEN-Grenoble, 38, France. D.R.F.C/S.I.G.). May 1986. NTIS (US Sales Only), PC A04/MF A01. File Number DE87751062. (CONF-860412—Pt.1).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Lower hybrid current drive experiments on the Petula B tokamak have already shown strong modifications of the plasma behaviour when a fast electron population is sustained by lower hybrid waves. The main response of the plasma to the absorbed power is the current but various other responses can be analyzed. This paper reports an experimental and theoretical study on the use of the Electron Cyclotron Emission as a diagnostic for the absorbed H.F. power. The current, the conduction and the saturation of the absorption are observed and interpreted.

21860 **(EUR-CEA-FC—1296) Annual report on theoretical work of the STGI (section de theorie des gaz ionises).** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). 1985. 26p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751049.

This report presents theoretical work on plasma equilibrium, macroscopic plasma evolution and transport codes, waves and RF heating, plasma instabilities magnetic islands and turbulence, transport coefficients and scattering of near-resonance radiation.

21861 **(EUR-CEA-FC—1299) Study, realization and operation of a fast amplitude selector for X-ray spectrometry in thermonuclear plasma.** Allard, P. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). Jun 1986. 135p. (In French). NTIS (US Sales Only), PC A07/MF A01. File Number DE87751051.

A semiconductor diode detector is here used to measure soft X radiation emitted by a plasma. Energetic resolution, in this case, is enough for electron study to improve time resolution - for use on Petula - a fast amplitude selector has been used with a good channel number. The Si(Li) diode X spectrometry system is detailed. For amplitude coder, "video coders" have been chosen which are parallel coders in integrated circuits. The different modules (coder rock memory one, visualization, Camac interface) of the multichannel analyzer are presented. Amplitude, selector characteristics are detailed, they are measured with pulses directly applied to the coder stage. Measurements made with the complete spectrometry system are shown; they are made successively with radioactive sources ($^{55}$Fe and $^{93}$Nb), with a simulation generator and with the X radiation of Petula plasma.

21862 **(EUR-CEA-FC—1300) One-dimensional transport codes MAKOKOT. Presentation and directions for use.** Capes, H.; Mercier, C.; Morera, J.P.; Haquang, D.; Cissoko, G.; Chavazas, J.M. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). Jun 1986. 59p. (In French). NTIS (US Sales Only), PC A04/MF A01. File Number DE87751052.

In this note are presented the different one-dimensional evolution codes available to date under the generic name MAKOKOT. They are six principal codes: - TRANS: for ion and electron transport; -NEUTRE: for neutrals; -IMPUR: for impurities; -ECRH: for

electron cyclotron resonance; -DENT: for sawtooth modelling and analysis; -BILAN: for global verification of conservation. One supplementary code is added which is an impurity evolution code; it takes in account, in 1-D geometry, the buffer zone generated by the limiter between the hot plasma and the wall. An abundant bibliography is given. A comprehensive manner of using is given which underlines the use versatility of these codes.

21863 **(GA-A—18596) Characteristics of reversed field pinch plasmas with a resistive shell.** Tamano, T.; Bard, W.D.; Chu, C.; Carlstrom, T.N.; Goforth, R.R.; Kondoh, Y.; La Haye, R.J.; Lee, P.S.; Nilles, E.J.; Saito, M.T.;. (GA Technologies, Inc., San Diego, CA (USA)). Jan 1987. Contract FG03-86ER53228. 12p. (CONF-861106—16). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005383.

From IAEA international conference on plasma physics and controlled nuclear fusion research; Kyoto, Japan (12 Nov 1986).

Reversed field pinch plasmas in a resistive shell have been investigated in the OHTE device. Discharges were sustained over 10 ms, much longer than the resistive shell time of 1.5 ms. Global plasma characteristics such as plasma temperature, density, resistance and magnetic fluctuations were very similar to those obtained with the previous highly conducting shell. A new type of toroidally localized kink instability, which we named the "slinky" mode, was found. It initially grew with a growth time of approximately the resistive shell time as the linear MHD theories have predicted, but self-healing was usually observed within a few milliseconds. This indicates that a highly conducting shell may not be required for a reversed field pinch, and suggests that linear plasma stability is not always necessary in a confinement system.

21864 (IA—1421, pp 41) **Radiation transport and preheat calculations of laser irradiated Al targets.** Krumbein, A.D.; Salzmann, D.; Szichman, H. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21865 (IA—1421, pp 41-42) **Two-dimensional analytical considerations of large magnetic and electric fields in laser produced plasma.** Eliezer, S.; Loeb, A. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21866 (IA—1421, pp 42) **Free electron laser and laser electron accelerations based on the mega-gauss magnetic fields in laser produced plasmas.** Loeb, A.; Eliezer, S. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21867 (IA—1421, pp 43-44) **Non-equilibrium excitation phenomena near the plasma-substrate surface in a low pressure microwave plasma.** Khait, Y.L.; Inspektor, A.; Carmi, U.; Avni, R. (Ben-Gurion Univ. of the Negev, Beersheba, Israel; Israel Atomic Energy Commission, Tel Aviv). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21868 (IA—1421, pp 41) **Use of unresolved transition arrays for diagnosis of hot plasma.** Zigler, A.; Jackel, S.; Ludmirsky, A.; Klapish, M.; Meroz, E.; Bar Shalom, A. (Israel Atomic Energy Commission, Tel Aviv; Hebrew Univ., Jerusalem, Israel). Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21869 (IA—1421, pp 44) **Evolution of strong shock waves produced by a trapezoidal laser pulse.** Loeb, A.; Eliezer, S.; Zigler, A.; Arad, B.; Ludmirsky, A.; Gazit, Y.; Jackel, S.; Krumbein, A.D.; Borowitz, J.L.; Gilath, I. Jun 1986. NTIS (US Sales Only), PC A12/MF A01. File Number DE87780103.

Published in summary form only.
In Research laboratories annual report 1985.

21870 **(IAEA-CN—47/A-III-4) Pellet injection results during TFTR Ohmic and neutral beam heating experiments.** Schmidt, G.L.; Milora, S.L.; Arunasalam, V.; Bell, M.G.; Bitter, M.; Bush, C.E.; Combs, S.K.; Dylla, H.F.; Efthimion, P.C.; Fredrickson, E. (Princeton Univ., NJ (USA). Plasma Physics Lab.; Oak Ridge National Lab., TN (USA); Oxford Univ. (UK). Balliol Coll.; EG and G Idaho, Inc., Idaho Falls (USA); Commission of the European Communities, Abingdon (UK). JET Joint Undertaking; International Atomic Energy Agency, Vienna (Austria)). 1986. Contract AC05-84OR21400;AC02-76CH03073. 9p. (CONF-861106—18). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005717.

From IAEA international conference on plasma physics and controlled nuclear fusion research; Kyoto, Japan (12 Nov 1986).

In Ohmic discharges, pellet injection experiments on TFTR have increased density limits and energy confinement. Injecting multiple pellets sustains the improved confinement and increases the central density and peaked character of the profile, producing significant increases in n/sub e/(0)tau/sub E/(a). A value of (1.4 +- 0.3) x $10^{20} m^{-3}$ . s has been achieved at a central electron temperature of 1.4 keV. Decay of the central density for strongly peaked profiles in Ohmic discharges is consistent with central particle diffusion coefficients of 0.1 $m^2/s$ and flow velocities on the order of neoclassical velocities. Concentrations of scandium injected following pellet injection (n/sub Sc//n/sub e/) exhibit an extended rise time and then remain roughly constant during the subsequent slow decay of the electron density. In pellet-fueled discharges heated by tangential neutral beams at high density, heating profiles vary from a flat radial shape to a profile that is peaked near the q = 2 radius. Global confinement is comparable to that obtained in gas-fueled discharges with similar total input power but with heating profiles more strongly peaked on axis. Central confinement in pellet-fueled discharges exceeds values obtained in gas-fueled discharges.

21871 **(ILE—8509P) Integral representation of nonlinear heat transport.** (Osaka Univ., Suita (Japan). Inst. of Laser Engineering). Jul 1985. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700914.

The electron distribution function in a plasma with steep temperature gradient is obtained from a Fokker-Planck equation by Green's function method. The formula describes the nonlocal effects on thermal transport over the range, $\lambda/sub\ e//L < 0.1$. The formula includes the self-consistent electrostatic potential and exactly recovers the Spitzer-Haerm thermal conductivity in the long scale length limit, $\lambda/sub\ e//L \to 0$. As an example, the heat wave is analyzed numerically by the integral formula and it is found that the previous simulation results are well reproduced.

21872 **(INIS-mf—4754-No.34) International Bulletin on Atomic and Molecular Data for Fusion. No. 34.** Smith, J.J. (ed.). (International Atomic Energy Agency, Vienna (Austria). Atomic and Molecular Data Unit). Sep 1986. 103p. NTIS (US Sales Only), PC A06/MF A01. File Number DE87700925.

This bulletin deals with atomic and molecular data for fusion. A bibliography of the most recent relevant data is provided (499 literature pieces). An author index is included.

21873 (INIS-mf—10565, pp 3-6) **On electron acceleration with the potential waves excited in a plasma by the strong SHF field.** Karfidov, D.M.; Sergejchev, K.F. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780085.

Kratkie Soobshcheniya po Fizike. No. 3.
In Experimental and theoretical physics. Collection.

Possibility of electron capture into a high-frequency potential wave with a phase velocity exceeding the thermal electron velocity 3-4 times was considered under conditions of existence of kinetic parametric plasma instability. Acceleration estimates were compared with experimental data.

21874 (INIS-SU—380, pp 16-20) **Microchannel analyzer for diagnostics of corpuscular and X-ray emission of a laser plasma.** Barabash, L.Z.; Bragin, B.N.; Golubev, A.A. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780086.

Kratkie Soobshcheniya po Fizike. No. 5.

In Experimental and theoretical physics. Collection.

In investigations on laser heating and compression of spherical targets ensuring of uniformity of irradiation and symmetry of the produced plasma corona and compressed non evaporated part of the target are of a great importance. Due to this fact one of the main diagnostics problems is the development of special apparatus which permits the diagnostics of the high-temperature plasma image with spatial resolution of 10/sup -2/ mm and time resolution of 10/sup -10/ s. The microchannel analyzer for diagnostics of images in various spectral ranges of X-ray and corpuscular emission of a laser plasma is developed. The microchannel plate (MCP) of the analyzer transforms X-ray, ultraviolet radiation and ion fluxes into that of electron one. MCP external diameter is 40 mm, channels diameter (13 μm) determine the spatial resolution. The electron flow is amplified in MCP 10/sup 2/-10/sup 4/ times (depending on MCP voltage value) and then is transferred by 5 kV plane-parallel field onto aluminized luminescencent screen where it is transformed into visible radiaion. Image diagnostics is realized y a high-sensitive photofilm (Photo-250). Sensitivity calibration in the X-radiation range of 1-19 keV and ion energy of 1-10 keV is performed.

21875 (INPE—3977) **Influence of a strong laser field on the stopping power for charged test particles in fusion plasmas.** (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). Aug 1986. 26p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700930.

The influence of a high-intensity electromagentic wave on the classical energy loss rate of ion in nondegenerate plasmas is calculated. It is shown that the laser field decreases the plasma stopping power and makes it anisotropic with respect to the polarization of the wave electric field.

21876 (INPE—3978) **Reduction of the general Spitzer-Haerm problem in plasma physics.** (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). Aug 1986. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700931.

The general Spitzer-Haerm problem is unfolded through a redefinition of the dependent variable into two separate simpler problems. The first takes the form of a second order differential equation, and the second, that of an integration over the solution of the first problem, which provides the distribution function or, directly, the current and the heat flow. It is shown that the current and the heat flow can in general be synthesized from the solutions of the differential equation for two specific forms of the driving term.

21877 (IPP—2/283) **Magnetic surfaces and localized perturbations in the Wendelstein VII-A stellarator.** Wobig, H. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). Sep 1986. 21p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751278.

The critical dependence of plasma confinement in low-shear stellarators, such as Wendelstein VII-A, on the external rotational transform can be explained on the basis of magnetic surface destruction. External symmetry-breaking perturbations generate islands on the low order rational magnetic surfaces. The islands are largest at t=1/2 and t=1/3. Confinement is optimum in close proximity to these values. In order to study the structure of surfaces under the influence of perturbations, a mapping procedure is used instead of field line integration. It is found that the neighbourhood of low- order rational surfaces is particularly robust against surface destruction. The reason is that in this vicinity only rational surfaces with large m and n exist (t=m/n). On these surfaces the external perturbation only generates small islands. In W VII-A the current leads to the helical windings are one symmetry- breaking perturbation, and there might also be others. It is possible to avoid field errors of this kind in future stellarators.

21878 (IPP—5/6) **Magnetohydrodynamic equilibrium calculations using multigrid.** Braams, B.J. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). Sep 1985. 19p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751279.

The multigrid method has been applied to the solution of the two-dimensional elliptic equation that governs axisymmetric ideal magnetohydrodynamic equilibrium. The possibility of applying multigrid to the computation of axisymmetric equilibria in the 'inverse coordinates' formulation and to three-dimensional equilibrium and evolution calculations is investigated.

21879 (IPP—5/11) **Numerical simulation of reflectometry density measurements in a reversed field pinch.** Brambilla, M.; Moresco, M. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). Sep 1986. 39p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751277.

The reflection of an Ordinary Wave from its cut-off at the electron plasma frequency can be exploited to measure the density profile of laboratory plasmas. We present two codes for the numerical simulation of broad band reflectometry on a Reversed Field Pinch. The RAYRFP code evaluates the h.f. field distribution in the geometric optic approximation. It can rapidly simulate a frequency scan by evaluating the optical length of the 'central' ray. It can also be used for example to estimate the angular spread of the reflected wave due to refraction and reflection from a cylindrical convex surface. Because of the large shear characteristic of Reversed Field Pinches, coupling between the ordinary and the extraordinary modes in the plasma can be important. Mode mixing is investigated by solving the full wave equation for nearly equatorial waves with a finite element code FELRFP. The results show that indeed a non negligible amount of power can be transferred from the launched O-mode to the unwanted X-mode (or viceversa). Although stronger in small devices, this effect can also be substantial when the optical path is long, even in plasmas so large that the variation of B per wavelength is small. The mixing coefficient is found to be an oscillating function of frequency, indicating that the excitation of standing waves between the plasma edge and the cut-offs also plays a role. Nevertheless, the implementation of reflectometry should still be possible without difficulty in sufficiently large devices.

21880 (IPP—III/110, pp 53-56) **Local transport in tokamaks with ohmic and injection heating.** Becker, G. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching, Germany, F.R.). May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

The anomalous electron heat diffusivity CHI/sub e/ is investigated by a power scan of the injection heating and by the time evolution of L (low confinement) discharges. It is shown that deviations from the ohmic scaling occur if the non-ohmic electron heating locally exceeds the ohmic power density. The change in scaling is attributed to the injection heating with its different dependence on the plasma parameters rather than to other instabilities or saturation effects. Constraints on CHI/sub e/ are derived from the electron and ion energy equations and the shape of the measured electron temperature profiles. For small injection power complex CHI/sub e/ scalings result which cannot be represented by superposing the ohmic and L scalings.

21881 (IPP—III/110, pp 62-65) **Dimensionality of fluctuations in ASDEX.** Battiston, L. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching, Germany, F.R.). May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Dimensionality analysis of experimental series of data has revealed a new powerful tool for a deeper understanding or turbulent physical systems. The analysis of the so-called strange attractors provides a tool to identify the fractal dimension $\nu$ of a time series. This fractal dimension is associated with the number of independent processes which characterize the system, and if it exists, it provides a distinction between deterministic chaos and noise.

21882 (IPP—III/110, pp 71-76) **Free-boundary flow equilibria for ASDEX-UG.** Zehrfeld, H.P. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching, Germany, F.R.). May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Neutral beam injection into magnetically confined plasmas is connected with plasma flow and a corresponding alteration of the equilibrium characteristics of the discharge. In particular density variations on magnetic surfaces were observed in neutral beam heated plasmas. This has led to attempts to explain them by toroidal rotation of the plasma. Due to the finite rotational transform of the flow field accelerating forces in toroidal direction appear. In an equilibrium state, they must be balanced by corresponding components of jxB. This requires plasma currents across magnetic surfaces which together with the toroidal magnetic field maintain pressure gradients in magnetic surfaces. In order to demonstrate this effect quantitatively corresponding MHD flow equilibria have been calculated for the separatrix-bounded plasma configurations.

21883 (IPP—III/110, pp 119-123) **Coupling of lower hybrid waves to the ASDEX plasma.** Zouhar, M.; Vien, T.; Leuterer, F.; Muenich, M.; Brambilla, M.; Derfler, H.; Eckhartt, D.; Woyna, F. v. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching, Germany, F.R.). May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

The ASDEX-Lower-Hybrid experiment uses an eight waveguide grill antenna to launch the waves. A mean power reflection coefficient as low as $<R>=0.1$ is attainable in all modes of operation. However the reflection coefficients R/sub k/ in the individual waveguides may vary over a great range (up to 0.9). This paper aims at depicting the reflection patterns R/sub k/=f(k) and comparing measurement with theory. At high power levels (above 140 kW/waveguide) a breakdown occurs. The sequence of phenomena relating to this breakdown is documented and commented on.

21884 (IPP—III/110, pp 35-40) **Energy and particle transport in medium-density ASDEX pellet discharges.** Gruber, O.; Jilge, W.; Mertens, V.; Vlases, G.; Kaufmann, M.; Lang, R.; Sandmann, W.; Buechl, K.; Bosch, H.S.; Brocken, H. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

In ASDEX a comparison of ohmically heated divertor discharges with gas fuelling (GF) and pellet fuelling (PF), without any gas puffing after a gas puff 'start-up' phase, has been done. This paper deals with a detailed comparison of the radial transport of the pellet-fuelled and the gas-fuelled discharges with the transport analysis code TRANSP using the measured radial profiles of n/sub e/, T/sub e/ and radiation losses.

21885 (IPP—III/110, pp 41-44) **Analysis of the invariance property of the electron temperature during auxiliary heating in ASDEX.** Murmann, H.; Wagner, F.; Becker, G.; Bosch, H.S.; Brocken, H.; Eberhagen, A.; Fussmann, G.; Gehre, O.; Gernhardt, J.; Gierke, G. v. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

A crucial and still unsolved problem in tokamak physics is the understanding of anomalous heat transport across the magnetic field via heat conduction of the electrons. All efforts to establish a universal expression for the diffusivity CHI/sub e/ as a function of local plasma parameters which is valid also for auxiliary heating have failed so far. The problem has become even greater since it became evident that plasma confinement deteriorates during additional heating in a parameter range that is still very close to ohmic heating conditions.

21886 (IPP—III/110, pp 45-48) **Particle confinement in ohmically heated ASDEX plasmas.** Gehre, O.; Becker, G.; Eberhagen, A.; Bosch, H.S.; Brocken, H.; Fussmann, G.; Gernhardt, J.; Gierke, G. v.; Glock, E.; Gruber, O. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

The anomalous particle transport in ohmic deuterium and hydrogen discharges is investigated by scans of the plasma current, density and toroidal magnetic field. At smaller current or larger ion mass more peaked density profiles are found. The flux-surface-averaged transport is analysed by computer simulations. It is shown that the inward drift velocity is independent of the poloidal and toroidal magnetic field and the ion mass number but inversely depends on the density and electron temperature. Empirical scaling relations for the electron heat diffusivity and the diffusion coefficient are also presented.

21887 (IPP—III/110, pp 49-52) **Neutral beam deposition experiments at elevated densities in ASDEX.** Speth, E.; Gruber, O.; Janeschitz, G.; Murmann, H.; Niedermeyer, H.; Wagner, F.; Vollmer, O.; Becker, E.; Bosch, H.S.; Brocken, H. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

In the past the penetration requirements for neutral beams have been derived from the postulate that the beam power should be deposited near the plasma axis. It has been demonstrated theoretically that the shape of the deposition profile is governed by the parameter $a/\lambda$ (a=minor plasma radius, $\lambda$=mean free path of the injected neutrals at line-averaged density). In order to make an experimental assessment of the required beam penetration a series of experiments were started in 1984 in ASDEX, in which neutral beam deposition was varied systematically. This paper describes the continuation of the experiments at almost twice the density and three times higher power.

21888 (IPP—III/110, pp 57-61) **Transport in beam-heated ASDEX discharges below and in the vicinity of the beta limit.** Gruber, O.; Jilge, W.; Bosch, H.S.; Brocken, H.; Eberhagen, A.; Fussmann, G.; Gehre, O.; Gernhardt, J.; Gierke, G. v.; Glock, E. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Radial transport and confinement properties of ohmically and beam-heated ASDEX discharges are studied using the PPPL transport analysis code TRANSP and measured radial plasma profiles and global parameters. Results are that the anomalous electron thermal transport is dominating in low-density ohmic as well as 'L' beam-heated ASDEX plasmas. It leads, however, for these regimes to different scaling laws of the global energy confinement time. At high-density ohmic and 'H' mode beam-heated discharges the neoclassical ion heat conductivity and convective losses (H mode) are comparable to the electron losses and tend to dominate the energy balance.

21889 (IPP—III/110, pp 66-70) **Influence of the current distribution on the achievable $\beta$-values in ASDEX.** Gierke, G. v.; Becker, G.; Bosch, H.S.; Brocken, H.; Buechl, K.; Eberhagen, A.; Eckhartt, D.; Fussmann, G.; Gehre, O.; Gernhardt, J. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

In a divertor tokamak the behaviour of surface kinks are unclear due to the unknown influence of the strong shear near the se-

paratrix. In ASDEX the influence of the separatrix is very concentrated and therefore the influence should be restricted to higher n-modes. As we observe no pronounced changes with varying q-values we assume tentatively that the ballooning mode is responsible mainly for the observed limit.

21890 (IPP—III/110, pp 77-80) **MHD characteristics of ASDEX H-type discharges approching the $\beta$ limit.** Klueber, O.; Gernhardt, J.; Grassie, K.; Hofmann, J.; Kornherr, M.; Zehrfeld, H.P.; Becker, G.; Bosch, H.S.; Brocken, H.; Eberhagen, A. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Due to the favourable confinement properties of the H regime, $\beta$ values close to the Troyon limit can be achieved in the ADSEX device at a neutral injection power level proportional to 3 MW. In many cases, the $\beta$ limit is a soft one, i.e. $\beta$ attains a maximum and then decays smoothly up to the end of the injection pulse. Disruptions, however, may occur both during the rise and fall of $\beta$.

21891 (IPP—III/110, pp 81-84) **MHD-effects with NI and ICRF heating on ASDEX.** Kornherr, M.; Eberhagen, A.; Gernhardt, J.; Klueber, O.; Wagner, F.; Becker, G.; Bosch, H.S.; Brocken, H.; Fussmann, G.; Gehre, O. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

With high power auxiliary heating at increased plasma pressure many new MHD phenomena occur which can be studied most suitable by observation of the soft X-ray ('SX') radiation. In the plasma centre NI excites large m=1, n=1 oscillations, the detailed behaviour of which depends on external parameters. In divertor discharges with NI power < or approx. 2 MW their occurrence is repetitive and terminated hy sawteeth. When NI is combined with ICRH the m=1 mode often disappears after a first strong sawtooth which is followed by 'precursor-free' large sawteeth.

21892 (IPP—III/110, pp 85-88) **ICRF H-mode and 2Ω/sub CH//D(H)-minority heating on ASDEX.** Steinmetz, K.; Wagner, F.; Wesner, F.; Noterdaeme, J.M.; Baeumler, J.; Becker, G.; Bosch, H.S.; Brambilla, M.; Braun, F.; Brocken, H. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

ICRH experiments in the ASDEX divertor tokamak have now been operated in the 2Ω/sub CH/ regime and D(H)-minority mode. This paper presents the status of these investigations and compares some of the most interesting features of the RF scenarios with neutral beam heating (NI) in the same machine under optimized and reproducible plasma parameters. The achievement of the H-mode with ICRH alone is reported. Considerations on possible synergetic effects of the combination of ICRH with NI and impurity studies during ICRH are presented separately.

21893 (IPP—III/110, pp 89-92) **Role of the Faraday screen in ICRF antennae: Comparison of an optically open and optically closed screen in ASDEX.** Noterdaeme, J.M.; Soell, M.; Baeumler, J.; Becker, G.; Bosch, H.S.; Brambilla, M.; Braun, F.; Brocken, A.; Eberhagen, A.; Fritsch, R. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

A Faraday screen has been used on RF antennae since the first days of heating experiments with ICRF waves. Its use on the C-stellarator brought major improvements in the heating efficiency of the plasma. In subsequent heating experiments on other machines the beneficial effect of a Faraday screen, after initial trials without it, was rediscovered on TFR, DIVA and ERASMUS. Consequently the Faraday screen has become a mandatory component of ICRF antennae, and it has been attributed different functions. To fulfill those functions the screen has become increasingly complicated, and in the next generation of experiments, where the screen has to be cooled, a new round of complexity is added. Can the screen be simplified, and are some of its attributed functions really needed. Those questions were the basis for an experiment on ASDEX.

21894 (IPP—III/110, pp 93-96) **Comparison of ICRH and LH accelerated hydrogen ions in NI heated ASDEX plasmas.** Ryter, F.; Brocken, H.; Leuterer, F.; Maassberg, H.; Mayer, H.M.; Soeldner, F.X.; Steinmetz, K.; Becker, G.; Bosch, H.S.; Eberhagen, A. (CEA Centre d'Etudes Nucleaires de Grenoble, 38, France). May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

In ASDEX, ICRH and LHH or LHCD have been applied separately to NI preheated plasmas in the L regime (H/sup 0/->D/sup +/, energy E/sub B/). The coupling of these waves to beam ions (H/sup +/) have been studied with charge exchange diagnostics. Shots were made with E/sub B/=29 keV and E/sub B/=42 keV and in the latter case P/sub NI/ or P/sub RF/ were scanned.

21895 (IPP—III/110, pp 97-100) **Stabilisation of sawteeth oscillations by lower hybrid waves in ASDEX.** Soeldner, F.X.; Eckhartt, D.; Leuterer, F.; McCormick, K.; Becker, G.; Bosch, H.S.; Derfler, H.; Eberhagen, A.; Fussmann, G.; Gehre, O. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Stabilisation of sawteeth has become a clue problem for high power additional heating in large tokamaks where the oscillations in the central electron temperature may be as high as 50%. In Lower Hybrid experiments the sawteeth of Ohmic discharges have been observed to disappear. In this paper we study the parameter range for stabilisation of sawteeth accessible with the LH-system on ASDEX. The role of the LH wave spectrum is discussed. For application to NBI heating the LH-power requirements and the benefits for the energy confinement in sawtooth-free discharges are investigated.

21896 (IPP—III/110, pp 101-104) **Influence of the N-spectrum on lower hybrid current drive in ASDEX.** Leuterer, F.; Brambilla, M.; Eckhartt, D.; McCormick, K.; Muenich, M.; Soeldner, F.X.; Zouhar, M.; Becker, G.; Bosch, H.S.; Brocken, H. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

The lower hybrid current drive experiments in ASDEX so far have been performed mainly by operating successive waveguides of the grill at a relative phase of $\Delta phi = \pi/2$ and with equal amplitudes. The spectrum thus excited is considered in this paper as a reference spectrum. With such a spectrum it has been observed that the primary current rate of change, -dI/dt/sub OH/, necessary to maintain a constant plasma current I/sub p/, decreased with increasing RF-power, P/sub RF/. In this paper we describe experiments with 'tailored' spectra where phase and amplitude in each waveguide are specifically set to produce a N'-spectrum with a definite wing at the high N'-side.

21897 (IPP—III/110, pp 105-108) **Measurements of non-thermal electron population during lower-hybrid heating in ASDEX.** Bartiromo, R.A.; Giuliana, A.; Hesse, M.; Soeldner, F.X.; Fussmann, G.; Leuterer, F.; Murmann, H.; Eckhartt, D.; Eberhagen, A.; Becker, G. (ENEA, Frascati, Italy; CEA Centre d'Etudes Nucleaires de Grenoble, 38, France). May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

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The aim of the present paper is to study the plasma-wave interaction by experimentally determining the fractional population of non-thermal electrons under different plasma conditions. The experiments were carried out on the ASDEX divertor tokamak, where current drive and plasma heating can be studied up to an in-

jected power of 1 MW at a frequency of 1.3 GHz. By changing the relative phase between successive elements in an eight-waveguide grill, the shape of the N' index spectrum as well as its directionality can be controlled.

21898 (IPP—III/110, pp 109-114) **Influence of the lower hybrid wave spectrum on the current distribution in ASDEX.** McCormick, K.; Soeldner, F.X.; Leuterer, F.; Murmann, H.; Eckhartt, D.; Becker, G.; Bosch, H.S.; Brocken, H.; Eberhagen, A.; Fussmann, G. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Measurements of the plasma current density distribution j(r) during injection of stationary or propagating lower hybrid wave spectra have been performed on ASDEX. Positive current drive leads to broader j(r) profiles - while T/sub e/(r) is peaking - coupled with an increase in q from q< or approx. 1 to q>1. The other spectra influence j(r) only to the extent predicted from classical conductivity based on changes in T/sub e/(r) under the condition q(0)proportional to 1.

21899 (IPP—III/110, pp 115-118) **Probe measurements of plasma inhomogeneities in the scrape-off layer of ASDEX during LH.** Lenoci, M.; Haas, G.; Becker, G.; Bosch, H.S.; Brocken, H.; Eberhagen, A.; Eckhartt, D.; Fussmann, G.; Gehre, O.; Gernhardt, J. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

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Electron temperature and density have been measured routinely at the edge of the ASDEX main plasma by means of a Langmuir triple probe which gives the saturation current and T/sub e/ on-line. Therefore one can get with a fast radially moved triple probe a complete n/sub e/(r) and T/sub e/(r) profile in one shot. The probe installed in ASDEX can be moved from a preset position 100 mm radially inward and backward within 200 msec. It is placed 22.50/sup 0/ toroidally away from the LH launching grill and 5/sup 0/ poloidally above the equatorial plane; the tips are arranged in the form of a triangle with distances of 7 mm. For a proper function of triple probes it is necessary that the deviations between the floating potentials of the 3 tips are small compared to T/sub e//e. In ohmic discharges this is fulfilled while during LH application we observed differences of the order of T/sub e//e. We have investigated this under different plasma and LH parameters.

21900 (IPP—III/110, pp 136-139) **Measurements of charged fusion products in ASDEX.** Bosch, H.S.; Schumacher, U.; Becker, G.; Brocken, H.; Eberhagen, A.; Eckhartt, D.; Fussmann, G.; Gehre, O.; Gernhardt, J.; Gierke, G. v. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

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For normal deuterium operation in ASDEX (A=4.1, I/sub p/=250-400 kA) the charged fusion products from the D-D reactions (3 MeV proton, 1 MeV triton and 0.8 MeV /sup 3/He) escape from the plasma on helical orbits to the upper part of the vessel. Since slowing-down can be neglected in ASDEX, the protons and tritons escape on identical orbits, because the trajectory depends only on the product mxv vector. The measurements of the charged fusion products give information on the ion temperature, fusion yield, and plasma behaviour. The charged fusion products were measured for ASDEX deuterium plasmas by using a surface barrier detector or nuclear emulsion foils, installed on a manipulator.

21901 (IPP—III/110, pp 140-143) **Periodic Thomson scattering diagnostic with 16 spatial channels on ASDEX.** Meisel, D.; Murmann, H.; Roehr, H.; Steuer, K.H.; Becker, G.; Bosch, H.S.; Brocken, H.; Eberhagen, A.; Fussmann, G.; Gehre, O. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

The Nd-YAG Periodic Scattering System (PSS) was developped in teamwork with IPF of Stuttgart-University. At first a PSS with only one spatial channel was successfully tested in the ASDEX-Tokamak in 1982. Subsequently an upgraded system with 16 spatial channels was constructed. This new system is capable of measuring Te, Ne-profiles at 17 ms intervals during the entire ASDEX-Tokamak-discharge. The PSS has been working successfully for the last one and a half years as a standard diagnostic method in the ASDEX-Tokamak. This means, that the measurement is being automatically performed during all plasma-discharges. The Te- and Ne-values are stored in the ASDEX-computer and every user has the possibility to get the Te(r,t), Ne(r,t)-data for his own needs.

21902 (IPP—III/110, pp 144-147) **Measurement of plasma emission profiles in the range from 800-1000 nm for Z/sub EFF/-analysis in ASDEX.** Roehr, H.; Steuer, K.H.; Meisel, D.; Murmann, H.; Becker, G.; Bosch, H.S.; Brocken, H.; Eberhagen, A.; Fussmann, G.; Gehre, O. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

We report the attempt to use the 16-point ND-YAG Thomson scattering device on ASDEX for measurements of plasma radiation profiles as well. The system offers the possibility to measure three spectral ranges simultaneously: 780-880 nm, 900-970 nm and 985-1020 nm.

21903 (IPPJ—743) **Magnetohydrodynamic stability of spheromak plasma in toroidal flux conserver with rectangular cross section. 2. Application of Mercier criterion.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Aug 1985. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700941.

The magnetohydrodynamic equilibrium states by Hill's vortex model and by the Coulomb-wave-function model are proved to be unstable. New MHD equilibrium configurations are determined by using another model for which dp/dpsi = 0 on the magnetic axis. Here p is the pressure and psi is the flux function. The values of the safety factor on the magnetic axis, q/sub axis/, are evaluated for these configurations. The MHD stability of these equilibrium states is investigated by the Mercier criterion. The values of the maximum beta ratio $\beta$/sub max/ are evaluated for this model. The optimized pressure distributions are determined by use of the Mercier criterion and the values of $\beta$/sub max/ are also evaluated for these pressure distributions. The values of $\beta$/sub max/ are shown to be at most 12 %, if the condition q/sub axis/ < 1 is required.

21904 (IPPJ—744) **Particle fluxes in the banana regime due to RF wave injection.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Sep 1985. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700942.

The radial particle fluxes for a two ion species plasma are investigated in an axisymmetric toroidal magnetic field. As a wave-absorption mechanism, the ion-cyclotron damping is considered. The inward and outward fluxes of plasma ions and impurity ions are induced by the RF wave injection when the condition u/sub 0/ B/sub $\theta$/ > 0 is satisfied. Here u/sub 0/ is the phase velocity along the magnetic field and B/sub $\theta$/ is the poloidal magnetic field.

21905 (IPPJ—745) **Is the drift instability related to H-mode.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Oct 1985. 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700943.

The physical mechanism of the drift instability is reconsidered related to the "H-mode" in poloidal diverter tokamak plasma. We assume the collisionless drift wave is stabilized as a result of the quasilinear modification of the ion velocity distribution function which includes the particle drift terms along the magnetic field in the scrape-off plasma near the separatorix of the poloidal divertor tokamak. A freedom in the direction of magnetic field can stabilize the drift instability. The heat flux deposited to the divertor plate is expected to increase after H-mode transition.

21906 **(IPPJ—746) Current drive by fast magnetosonic waves near the lower hybrid frequency in the JIPP T-IIU tokamak.** Ohkubo, K.; Hamada, Y.; Ogawa, Y. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Oct 1985. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700944.

Current drive by fast magnetosonic waves is successfully performed in the JIPP T-IIU tokamak by means of a four-element dipole antenna array with Faraday shield. The plasma current of about 40 kA is sustained by RF power of about 50 kW in the low density plasma of 2 - 4 x 10/sup 12/ cm/sup -3/ with an efficiency comparable to that of the slow wave current drive. A clear density limit for fast magnetosonic current drive exists contrary to theoretical expectations based on linear wave propagation.

21907 **(IPPJ—747) Magnetohydrodynamic stability of spheromak plasma in spheroidal flux conserver. Application of Mercier criterion.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1985. 25p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700945.

The MHD equilibrium configurations of spheromak plasmas in a spheroidal flux conserver are determined by use of a pressure distribution whose derivative dp/dpsi vanishes on the magnetic axis, and by use of an optimized distribution. Here p is the pressure and psi is the flux function. These equilibria are shown to be stable for symmetric modes. The stability for localized modes is investigated by the Mercier criterion. The values of the maximum beta ratio $\beta$/sub max/ are evaluated for both pressure distributions and are shown to become about two times larger by optimization. If the condition, q/sub axis/ $< 1$, is required, the values of $\beta$/sub max/ are found to be less than 30%. The oblate spheroidal flux conserver is shown to be better than the toroidal conserver with a rectangular cross section from the standpoint of stability.

21908 **(IPPJ—748) Helical fluctuation in reversed field pinch (RFP) plasma.** Arimoto, H.; Nagata, A.; Sato, K.I. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1985. 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700946.

The overall behaviours of helical fluctuations in RFP plasma are examined. Immediately after the RFP configuration is set up, ordered helical fluctuation begins to occur, and at the nearly same time toroidal flux enhancement propagates towards the direction of electron current flow. In this phase m = 1, n = 10 — 12 modes, where m and n are poloidal and toroidal mode numbers, are generated in positive flux region. In the current termination phase, m = 2 mode is dominant.

21909 **(IPPJ—749) Poloidal rotation of reversed field pinch plasma.** Arimoto, H.; Sato, K.I.; Nagata, A. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1985. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700947.

The poloidal rotation of Reversed Field Pinch Plasma is clearly observed by the measurements of magnetic fluctuations and of Doppler shift of impurity lines. RFP plasma rotates in the direction of the electron diamagnetic drift to the toroidal field at the wall. Time behaviours of rotation frequency are examined. The rotation begins immediately after setting up RFP configuration and reaches maximum value before the peak current.

21910 **(IPPJ—750) Modern uses of Langmuir probes.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1985. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700948.

The Langmuir probe is adaptable to measurements in strong rf and strong magnetic fields such as exist in many fusion related experiments. Some new techniques, mostly untested, are described which could be developed to overcome the difficulties of this diagnostic method.

21911 **(IPPJ—751) Theory for resonant ion acceleration by nonlinear magnetosonic fast and slow waves in finite $\beta$ plasmas.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1985. 39p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700949.

A Korteweg de-Vries equation that is applicable to both the nonlinear magnetosonic fast and slow waves is derived from a two-fluid model with finite ion and electron pressures. As in the cold plasma theory, the fast wave has a critical angle $\theta$/sub c/. For propagation angles greater than $\theta$/sub c/ (quasi-perpendicular propagation), the fast wave has a positive soliton, whereas for angles smaller than $\theta$/sub c/, it has a negative soliton. Finite $\beta$ effects decrease the value of $\theta$/sub c/. The slow wave has a positive soliton for all angles of propagation. The magnitude of resonant ion acceleration (the $v$/sub p/ x B acceleration) by the nonlinear fast and slow waves is evaluated. In the fast wave, the electron pressure makes the acceleration stronger for all propagation angles. The decrease in $\theta$/sub c/ due to finite $\beta$ effects results in broadening of the region of extremely strong acceleration. It is also found that strong ion acceleration can occur in the nonlinear slow wave in high $\beta$ plasmas. Possibility of unlimited acceleration of ions by quasi-perpendicular magnetosonic fast waves is discussed.

21912 **(IPPJ—752) Plasma production with rotating ion cyclotron wave excited by Nagoya Type-III antennas in RFC-XX.** Okamura, S.; Adati, K.; Aoki, T. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1985. 36p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700950.

A method of plasma production with ion cyclotron wave heating was developed in RFC-XX. Nagoya Type-III antennas were used for the wave excitation and the gas supply was through a gas box. We investigated the effect of the rotating field excitation for the plasma production and heating. In m = -1 rotational mode (rotation in the direction of ion cyclotron motion), the plasma density profile is flat within the gas box bore with the line-integrated density nl = 3 x 10/sup 13/ cm/sup -2/ and the ion temperature T/sub i/ — 150 eV. For m = +1 mode, a high density plasma was obtained with a different profile which has a peak at the center. In this mode the line-integrated density is nl = 3 x 10/sup 14/ cm/sup -2/ with the peak density n(0) = 7 x 10/sup 13/ cm/sup -3/.

21913 **(IPPJ—753) Axial electric field driven by temperature anisotropy in a bumpy torus equilibrium.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1985. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700951.

Cyclotron heating effect on the axial equilibrium is studied in a bumpy torus geometry. It is found that the temperature anisotropy of warm heated species can generate axial potential variation along the magnetic field lines. The temperature anisotropy is analyzed with a bimaxwellian fluid model.

21914 **(IPPJ—754) 'Crescent'-shaped tokamak for compact ignition.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Dec 1985. 17p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700952.

A compact high-beta tokamak configuration with "crescent"-shaped (or "boomerang"-shaped) cross-section is proposed as a next-generation ignition machine. This configuration with a small indentation but a large triangularity is more compact than the normal dee-shaped design because of its high-beta characteristics in the first-second transition regime of stability. This may also be a more reliable next-generation compact device than the bean-shaped design with large indentation and small triangularity, because this design dose not rely on the second stability and is easily extendable from the present dee-shaped design.

21915 **(IPPJ—755) Influence of a hot particle component on plasma stability.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Dec 1985. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700953.

A hot particle component introduced into a background plasma can significantly alter the properties of both the equilibrium and perturbed states. In this work we will review various aspects of the problem together with the underlying physics.

**21916 (IPPJ—756) Tail anisotropy instability during plasma current rise by lower-hybrid waves in a tokamak.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jan 1986. 40p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700954.

Tail anisotropy instability during lower-hybrid current rise is investigated. Tail formation by lower-hybrid waves is studied by using a Fokker-Planck equation combined with the return field and the rf associated terms. Quasi-linear relaxation of the electron tail distribution under the influence of the plasma waves excited due to the instability is examined. It is found that the instability condition is related to the strength of the parallel diffusion by lower-hybrid waves and the ratio of the electron cyclotron frequency to the electron plasma frequency. The time scale between the instability spikes and the suppression of the instability by electron cyclotron heating are also discussed.

**21917 (IPPJ—758) Kink stability of long ion layers.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jan 1986. 28p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700955.

By means of the two-fluid model, the kink stability of a long thin field-reversed ion layer immersed in a dense low-temperature background plasma is studied theoretically. The two-fluid variational quadratic form with the assumption of rigid displacements in the radial direction yields a new kink stability condition that includes the effect of the non-zero real frequency of the modes, which is due to the inertia of the ion layer. This effect is essential to explain the numerical results of Harned. As the ratio of the density of the background plasma to that of the ion layer increases, this new kink stability condition reduces to the conventional condition. The physical mechanism for the kink instability is discussed by the analogy with the electrostatic two-stream instability.

**21918 (IPPJ—759) Advanced ICRF antenna design for R-TOKAMAK.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jan 1986. 45p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700956.

The advanced ICRF antennas designed for the R-TOKAMAK (a proposal in the Institute of Plasma Physics, Nagoya University) are described. They are a standard loop antenna and a panel heater antenna for fast wave heating, and a waveguide antenna for ion Bernstein wave heating. The standard loop antenna is made of Al-alloy and has a simple structure to install because of radioactivation by D-T neutrons. For a high power heating, a new type antenna called 'Panel heater antenna' is proposed, and it has a wide radiation area and is able to select a parallel wave number. The field pattern of the panel heater antenna is measured. The feasibility of the waveguide antenna is discussed for the ion Bernstein wave heating. The radiation from the aperture of the double ridge waveguide is experimentally estimated with a load simulating the plasma.

**21919 (IPPJ—760) Volume produced H/sup -/, D/sup -/ ion source for proton accelerator and thermo-nuclear fusion research by sheet plasma, 1.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jan 1986. 30p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87700957.

In order to apply a sheet plasma type of volume produced H/sup -/, D/sup -/ ion source to injection of proton accelerators and neutral beam injection of thermo-nuclear fusion researches, a large sheet plasma of width 20 — 25 cm and length 30 cm is produced under a discharge current of 175 A, a H/sub 2/ or D/sub 2/ gas pressure of about 2.5 x 10/sup -3/ Torr and gas flow of (2.0 — 2.5) Torr l/sec in a magnetic field of (60 — 110) gauss. Thus, H/sup -/ or D/sup -/ ion current is extracted in a current density up to 19 mA/cm/sup 2/ or 16 mA/cm/sup 2/ which is uniform within 10% over a large area (above 250 cm/sup 2/) of the sheet plasma surface, and in an acceleration voltage up to 4.5 kV. Then, an electron current accelerated with H/sup -/ or D/sup -/ ions is reduced negligibly beyond a distance of 2 cm from final acceleration electrode.

**21920 (IPPJ-DT—118) Intelligent data recorder.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). 1985. 27p. (In Japanese). NTIS (US Sales Only), PC A03/MF A01. File Number DE87700960.

The intelligent data recorder has been developed to data acquisition for a microwave interferometer. The 'RS-232C' which is the standard interface is used for data transmission to the host computer. Then, it's easy to connect with any computer which has general purpose serial port. In this report, the characteristics of the intelligent data recorder and the way of developing the software are described.

**21921 (JAERI-M—85-173) Spectral data for highly ionized molybdenum, Mo VI - Mo XLII.** (Japan Atomic Energy Research Inst., Tokyo). Oct 1985. 119p. NTIS (US Sales Only), PC A06/MF A01. File Number DE87701003.

Wavelengths and energy levels for the molybdenum ions Mo VI to Mo XLII are compiled for use in diagnostics of high temperature plasmas.

**21922 (JAERI-M—85-216) ICRF heating experiments in JFT-2 tokamak.** (Japan Atomic Energy Research Inst., Tokyo). Jan 1986. 94p. (In Japanese). NTIS (US Sales Only), PC A05/MF A01. File Number DE87701012.

This is an experimental study of ICRF heating on JFT-2 Tokamak in Japan Atomic Energy Research Institute. In this study, we first clarified physical and engineering problems of ICRF heating of tokamak plasma. Next, we optimized the design of the ICRF heating system, and the plasma parameters for the heating. Finally, we could demonstrate a high efficiency of this additional heating method by launching RF power which is two or three times as large as an ohmic input power to a plasma. And we achieved following things. (1) We optimized a design of an antenna, and we improved a durability of the system for high voltage. With the result that we achieved the maximum power density on an antenna. (2) We demonstrated that electron heating regime and ion heating regime can be easily accessed by controlling plasma parameters. Also we found the optimum heating conditions in each heating regime. (3) We experimentally clarified the production mechanism of impurities during ICRF heating. We could reduce the influx of metal impurity ions to a plasma by employing low z materials for limiters and antenna shields. Consequently, we improved a heating efficiency of electrons. Next, we studied a power balance of plasma during ICRF heating, and we could compare heating characteristics of ICRF with other additional heatings on JFT-2.

**21923 (LBL—22457) Charge transfer and excitation in high-energy ion-atom collisions.** Schlachter, A.S.; Berkner, K.H.; McDonald, R.J.; Stearns, J.W.; Bernstein, E.M.; Clark, M.W.; Tanis, J.A.; Graham, W.G.; McFarland, R.H.; Stockli, M.P. (Lawrence Berkeley Lab., CA (USA); Western Michigan Univ., Kalamazoo (USA). Dept. of Physics; Ulster Univ., Coleraine (UK). Dept. of Physics; Missouri Univ., Rolla (USA). Dept. of Physics; Kansas State Univ., Manhattan (USA). Dept. of Physics; North Carolina State Univ., Raleigh (USA). Dept. of Physics). Nov 1986. Contract AC03-76SF00098;AC02-83ER13116. 23p. (CONF-8611124—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003540.

From 3. international workshop on cross sections for fusion and other applications; College Station, TX, USA (6 Nov 1986).

Coincidence measurements of charge transfer and simultaneous projectile electron excitation provide insight into correlated two-electron processes in energetic ion-atom collisions. Projectile excitation and electron capture can occur simultaneously in a collision of a highly charged ion with a target atom; this process is called resonant transfer and excitation (RTE). The intermediate excited state which is thus formed can subsequently decay by photon emission or by Auger-electron emission. Results are shown for RTE in both the K shell of Ca ions and the L shell of Nb ions, for simultaneous projectile electron loss and excitation, and for the effect of RTE on electron capture.

21924 **(PPPL—2391) Loss of confinement following a sawtooth internal disruption in PBX tokamak.** Takahashi, H.; Morris, W.; Sesnic, S.; Bol, K.; Fonck, R.; Grek, B.; Gammel, G.; Heidbrink, W.; Kaita, R.; Kaye, S. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Oct 1986. Contract AC02-76CH03073. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005626.

Some bean-shaped plasmas heated by neutral beam injection lose a large amount of energy ($\delta\beta$/sub p perpendicular//$\beta$/sub p perpendicular/ $\leqq$ 20%) within a short period (0.3 to 6ms) following a sawtooth internal disruption, indicating a momentary worsening of the confinement. The most severe ($\delta\beta$/sub p perpendicular//$\beta$/sub p perpendicular/ $>$ 20%) events lead to discharge termination. The internal disruptions in the PBX plasmas often have an unusually large inversion radius, up to 75% of the plasma half-width.

21925 **(PPPL—2392) Positron deposition in plasmas by positronium beam ionization and transport of positrons in tokamak plasmas.** Murphy, T.J. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Nov 1986. Contract AC02-76CH03073. 35p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005627.

In a recently proposed positron transport experiment, positrons would be deposited in a fusion plasma by forming a positronium (Ps) beam and passing it through the plasma. Positrons would be deposited as the beam is ionized by plasma ions and electrons. Radial transport of the positrons to the limiter could then be measured by detecting the gamma radiation produced by annihilation of positrons with electrons in the limiter. This would allow measurements of the transport of electron-mass particles and might shed some light on the mechanisms of electron transport in fusion plasmas. In this paper, the deposition and transport of positrons in a tokamak are simulated and the annihilation signal determined for several transport models. Calculations of the expected signals are necessary for the optimal design of a positron transport experiment. There are several mechanisms for the loss of positrons besides transport to the limiter. Annihilation with plasma electrons and reformation of positronium in positron-hydrogen collisions are two such processes. These processes can alter the signal and place restrictions ons on the plasma conditions in which positron transport experiments can be effectively performed.

21926 **(PPPL—2396) Geometrical effects in X-mode scattering.** Bretz, N. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Oct 1986. Contract AC02-76CH03073. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005612.

One technique to extend microwave scattering as a probe of long wavelength density fluctuations in magnetically confined plasmas is to consider the launching and scattering of extraordinary (X-mode) waves nearly perpendicular to the field. When the incident frequency is less than the electron cyclotron frequency, this mode can penetrate beyond the ordinary mode cutoff at the plasma frequency and avoid significant distortions from density gradients typical of tokamak plasmas. In the more familiar case, where the incident and scattered waves are ordinary, the scattering is isotropic perpendicular to the field. However, because the X-mode polarization depends on the frequency ratios and the ray angle to the magnetic field, the coupling between the incident and scattered waves is complicated. This geometrical form factor must be unfolded from the observed scattering in order to interpret the scattering due to density fluctuations alone. The geometrical factor is calculated here for the special case of scattering perpendicular to the magnetic field. For frequencies above the ordinary mode cutoff the scattering is relatively isotropic, while below cutoff there are minima in the forward and backward directions which go to zero at approximately half the ordinary mode cutoff density.

21927 **(PPPL—2407) HAIFA: A modular, fiber-optic coupled, spectroscopic diagnostic for plasmas.** Ramsey, A.T.; Turner, S.L. (Princeton Univ., NJ (USA). Plasma Physics Lab.; Science Applications International Corp., La Jolla, CA (USA)). Jan 1987. Contract AC02-76CH03073. 31p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87005616.

HAIFA is a modular, multichannel, fiber optically coupled spectroscopy diagnostic for tokamak plasmas. It operates in the visible, measuring H/sub $\alpha$/ radiation, the visible continuum from thermal bremsstrahlung, and selected impurity lines. HAIFA is characterized by high modularity and flexibility, good radiation resistance, high noise immunity, and low cost. Details of design, construction, and calibration are given. The analysis of visible bremsstrahlung radiation measurements to deduce the effective ionic charge in a plasma is discussed.

21928 **(SAIC—86/1981) Rf stabilization of ballooning modes in tokamaks.** D'Ippolito, D.A.; Myra, J.R.; Francis, G.L. (Science Applications International Corp., Boulder, CO (USA). Plasma Research Inst.). Dec 1986. 14p. (PRI—108). NTIS, PC A02/MF A01. File Number DE87005284.

The use of radiofrequency (rf) waves in the ion cyclotron range of frequencies (ICRF) is shown to stabilize ballooning modes in tokamaks when the frequency and spatial wave structure are appropriately chosen. The physics of rf stabilization may provide access to high-beta tokamak operation in the second stability regime and may also be useful in suppressing edge localized modes in present experiments.

21929 **(SAIC—86/3081-Appat.77) TENSOR: A code for computation of the relativistic high frequency conductivity tensor for a magnetized plasma with arbitrary electron distribution function in the "temperature" range of 50-500 KeV: Final report.** Tamor, S. (Science Applications International Corp., La Jolla, CA (USA)). Sep 1986. Contract AC05-84ER53184. 69p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87005519.

A code has been developed for computation of the relativistic conductivity tensor for a plasma described by an arbitrary user-supplied electron distribution function. The calculation is based upon a generalization of the new representation of the conductivity tensor obtained by Weiss. This paper contains a development of the underlying theory and discussion of the computational method as well as representative results for the refractive index assuming various Maxwellian and non-Maxwellian distribution functions. Listings of the routine and a driver which include complete user instructions are appended.

21930 **(SAIC—87/1562) Ion transport in toroidally rotating tokamak plasmas.** Catto, P.J.; Bernstein, I.B.; Tessarotto, M. (Science Applications International Corp., Boulder, CO (USA). Plasma Research Inst.). Feb 1987. Contract AC03-76ET53057. 53p. (PRI—110). NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006729.

An efficient and systematic treatment of classical and neoclassical transport in all regimes of collisionality is formulated which permits toroidal rotation speeds on the order of the ion thermal speed for arbitrary aspect ratio, cross section, and poloidal magnetic field strength. A more convenient but somewhat unconventional form of the reduced kinetic equation is derived that is shown to extend the previous form by properly retaining induced electric fields. The generalized kinetic and moment description is exploited to explicitly evaluate the radial fluxes of toroidal angular momentum and energy in a pure plasma via a variational formulation. The specific results obtained in the Pfirsch-Schlueter regime are substantially more general than previous evaluations and significant improvements are also made in the banana regime.

21931 **(UCRL—95992) Fusion research and plasma physics: A story of paradigms.** Post, R.F. (Lawrence Livermore National Lab., CA (USA)). 27 Jan 1987. Contract W-7405-ENG-48. 18p. (CONF-870247—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87005057.

From International Rosenbluth symposium on dynamics of particles and plasmas; Austin, TX, USA (2 Feb 1987).

Marshall Rosenbluth's contributions to the magnetic mirror research program are briefly reviewed. (MOW)

21932 **Monte Carlo estimates of particle and energy confinement times in a bumpy torus and a bumpy square with poloidal electric fields.** Tolliver, J.S.; Hedrick, C.L. (Oak Ridge National Laboratory, P.O. Box Y, Oak Ridge, Tennessee 37831). *Physics of Fluids;* **30**: No. 3, 870-877(Mar 1987). Contract AC05-84OR21400.

Since significant poloidal structure in the electrostatic potential in Elmo Bumpy Torus (EBT) has been observed experimentally [Phys. Fluids 28, 2848 (1985)] and predicted theoretically (C. L. Hedrick, submitted to Phys. Fluids), a Monte Carlo calculation has been used to make estimates of the particle and energy confinement times in EBT with varying degrees of asymmetry in the electric field. The code is applicable to the bulk ion population and the "cool" electron population in EBT, but not to the intermediate-energy electrons believed to be responsible for the formation of the potential. A similar calculation is possible for an alternate magnetic field configuration known as a bumpy square, which is expected to have more symmetric potential profiles because of much better centering of the particle orbits. The calculations indicate that the confinement time in a bumpy square would be two to three orders of magnitude better than in EBT.

21933 **Collisional effects on kinetic electromagnetic modes and associated quasilinear transport.** Rewoldt, G.; Tang, W.M.; Hastie, R.J. (Plasma Physics Laboratory, Princeton University, P.O. Box 451, Princeton, New Jersey 08544). *Physics of Fluids;* **30**: No. 3, 807-817(Mar 1987).

The general procedure for the analysis of low-frequency electrostatic and electromagnetic modes in toroidal geometry is now well known. In the collisionless limit, the relevant dynamics (e.g., trapped particles, resonances, etc.) can be treated appropriately. However, with the introduction of collisional effects it is customary, for tractability, to employ model collision operators of varying degrees of complexity. Guided by results of earlier studies of alternative collision operators in unsheared slab geometry and in toroidal geometry, an improved model collision operator is introduced here for calculating toroidal eigenmodes. Analytic and numerical results are presented to support its relevance and to demonstrate its improvement over earlier models. The associated quasilinear particle and energy transport coefficients for each species are also calculated, and compared with the usual D/sub j/$\simeq\kappa$/sub j/ $\simeq\gamma/k^2$/sub perpendicular/ estimate.

21934 **Computer-simulation studies of electron-beam propagation through plasma into vacuum.** Chang, C.R.; Reiser, M. (Electrical Engineering Department and Laboratory for Plasma and Fusion Energy Studies, University of Maryland, College Park, Maryland 20742). *Journal of Applied Physics;* **61**: No. 3, 899-906(1 Feb 1987).

A disk model is developed to simulate the propagation of a cylindrical relativistic electron beam through plasma into vacuum via collective acceleration of positive ions from the plasma. Simulation results show dynamic details of electron and ion flow not noticed previously. The high-energy tail in the ion distribution is attributed to motion of the virtual cathode early in time when the ions enter the system. A comparison between the computer simulation and our analytical model published earlier shows good agreement for the time average behavior of the particles.

21935 **Neoclassical transport in stellarators.** Ho, D.D.; Kulsrud, R.M. (Lawrence Livermore National Laboratory, University of California, Livermore, California 94550). *Physics of Fluids;* **30**: No. 2, 442-461(Feb 1987). Contract W-7405-ENG-48.

The stellarator neoclassical transport caused by particles trapped in local helical wells is calculated in the low-collisionality regime using a systematic expansion. The behavior of electron transport is found to be the same over a wide range of energies but the behavior of ion transport for low-energy ions is found to be different than that for high-energy ions. Furthermore, the electron fluxes do not vary with the change in the radial ambipolar electric field nearly as much as do the ion fluxes. Thus the particle diffusion is controlled by the electrons. A nonradial ambipolar electric field is induced by ion drift. This electric field enhances the transport by about 15%—20%. A convenient graphical method that allows one to determine the magnitude of the radial ambipolar field for machines with different parameters is presented. Numerical examples show that electron energy confinement time is comparable to the ion energy confinement time for all the different size stellarators studied. Although the neoclassical losses are large, it is shown that ignition can be achieved in a reasonably sized stellarator reactor. Finally, fron the standpoint of reactor economics, the confinement scaling law shows that in order to increase ntau, it is better to increase the aspect ratio than the overall dimensions of the reactor.

21936 **Entropy production and plasma relaxation.** Hameiri, E.; Bhattacharjee, A. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). *Physical Review [Section] A: General Physics;* **35**: No. 2, 768-777(15 Jan 1987).

Plasma relaxation, as well as the relaxation of more general diffusive systems, is discussed from a dynamical point of view. It is shown that a state which minimizes the rate of entropy production, as suitably defined, attracts neighboring states and thus causes relaxation. For plasmas, the entropy principle is compared with Taylor's hypothesis of energy minimization and is shown to explain observed experimental results. An iteration scheme based on the entropy principle is constructed, and enables numerical calculation of the relaxed state. The scheme arises more naturally than the "local potential" method of Glansdorff and Prigogine which is improved upon.

21937 **Observation of z-dependent impurity accumulation in the PBX tokamak.** Ida, K.; Fonck, R.J.; Sesnic, S.; Hulse, R.A.; LeBlanc, B. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Physical Review Letters;* **58**: No. 2, 116-119(12 Jan 1987).

Charge-dependent convective impurity transport is observed in the central core of PBX H-mode discharges by measurement of radial profiles for both low- and high-Z intrinsic impurities in the presence of strong sawtooth activity. The time-evolving Z/sub eff/ profile and central metallic densities are modeled to yield a diffuison coefficient and a Z-dependent inward convective pinch which are in general agreement with estimates of neoclassical transport in the central plasma region.

21938 **Three-dimensional particle simulation of drift-wave fluctuations in a sheared magnetic field.** Sydora, R.D.; Leboeuf, J.N.; Thayer, D.R.; Diamond, P.H.; Tajima, T. (Institute for Fusion Studies, The University of Texas at Austin, Austin, Texas 78712). *Physical Review Letters;* **57**: No. 26, 3269-3272(29 Dec 1986).

Three-dimensional particle simulations of collisionless drift waves in sheared magnetic fields were performed in order to determine the nonlinear behavior of inverse—electron-resonance dynamics in the presence of thermal fluctuations. It is found that stochastic electron diffuision in the electron-resonance overlap region can destabilize the drift-wave eigenmodes. Numerical evaluations based on a nonlinear electron-resonance broadening theory give predictions in accord with the frequency and growth rates found in the simulation of short-wavelength modes (k/sub y/rho/sub s/approx. $>1$).

21939 **Numerical simulation of Reversed-Field Pinch dynamics.** Schnack, D.D.; Barnes, D.C.; Mikic, Z.; Harned, D.S.; Caramana, E.J.; Nebel, R.A. (Science Applications International Corp., La Jolla, CA, USA; New York Univ., NY, USA. Courant Inst. of Mathematical Sciences; Los Alamos National Lab., NM, USA). *Computer Physics Communications;* **43**: No. 1, 17-28(Dec 1986). (CONF-860515—). Contract AC03-83ER53150.

From EPS conference on computational physics - computing in plasma physics; Partenkirchen, F.R. Germany (13 May 1986).

The Reversed-Field Pinch (RFP) is presented as a driven nonlinear dynamical system that evolves on time scales long compared with the fastest normal modes of the system. Numerical methods for the simulation of these processes, and examples of their application to experimentally observable phenomena, are presented.

21940 **Three-dimensional free boundary calculations using a spectral Green's function method.** Hirshman, S.P.; Van Rij, W.I.; Merkel, P. (Oak Ridge National Lab., TN, USA; Max-Planck-Institut fuer Plasmaphysik, Garching, Germany, F.R.). *Computer Physics Communications;* **43**: No. 1, 143-155(Dec 1986). (CONF-860515—). Contract AC05-84OR21400.

From EPS conference on computational physics - computing in plasma physics; Partenkirchen, F.R. Germany (13 May 1986).

Also published as report CONF-8605187--1.

The plasma energy W/sub p/ = ∫ sub(Ω/sub p/)(1/2B/sup 2/ + p)dV is minimized over a toroidal domain Ω/sub p/ using an inverse representation for the cylindrical coordinates R = ΣR/sub mn/(s) cos(mθ - nzeta) and ZETA = ΣZETA/sub mn/(s) sin(mθ - nzeta), where (s,θ,zeta) are radial, poloidal and toroidal flux coordinates, respectively. The radial resolution of the MHD equations is significantly improved by separating R and ZETA into contributions from even and odd poloidal harmonics which are individually analytic near the magnetic axis. A free boundary equilibrium results when Ω/sub p/ is varied to make the total pressure 1/2B/sup 2/ + p continuous at the plasma surface Σ/sub p/ and when the vacuum magnetic field B/sub v/ satisfies the Neumann condition B/sub v/ . dΣ/sub p/ = 0. The vacuum field is decomposed as B/sub v/ = B/sub 0/ + nablaPHI, where B/sub 0/ is the field arising from plasma currents and external coils and PHI is a single-valued potential necessary to satisfy B/sub v/ . dΣ/sub p/ = 0 when pnot = 0. A Green's function method is used to obtain an integral equation over Σ/sub p/ for the scalar magnetic potential PHI = ΣPHI/sub mn/ sin (mθ - nzeta). A linear matrix equation is solved for PHI/sub mn/ to determine 1/2B/sub v//sup 2/ on the boundary. Real experimental conditions are simulated by keeping the external and net plasma currents constant during the iteration. Applications to l=2 stellarator equilibria are presented.

21941 **Nonlinear ion heating in magnetized plasma by monochromatic low-frequency waves.** Roth, I.; Temerin, M. (Space Sciences Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 6, 910-914(Dec 1986).

Heating of ions by monochromatic low-frequency waves, propagating perpendicularly to a dipole magnetic field, is analyzed theoretically and verified by simulations. The nonlinear acceleration mechanism involves a distortion of the ion trajectory by the external wave. An ion feels along its distorted trajectory field components at twice the wave frequency. When the wave frequency equals half of the local gyrofrequency, the resulting wave field at the gyrofrequency accelerates the ion. The perpendicular acceleration and the parallel motion determine the interaction time and the final ion energy.

21942 **Beam-generated waves in a large plasma chamber.** Kellogg, P.J.; Monson, S.J.; Holzworth, R.H.; Jost, R.J. (School of Physics and Astronomy, Univ. of Minnesota, Minneapolis, MN 55455). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 6, 891-901(Dec 1986).

Plasma waves generated in a large vacuum chamber (20 x 30 m) by an electron beam of energy 0.5 to 2 keV, are measured. Both pre-beam plasma discharge (pre-BPD) and beam plasma discharge (BPD) states are investigated. The measured waves fall roughly into three categories: 1) a low-frequency spectrum with f << f/sub ce/, f/sub rho/; 2) a whistler mode spectrum; and 3) a high-frequency spectrum. The extremely low frequency waves are shown to be surface waves on a (nonneutral) plasma column but a higher frequency part of the low-frequency spectrum was not thoroughly investigated. It is speculated that it also represents surface waves on a nonneutral column. Its measured properties are consistent with the lower hybrid drift instability. The whistler mode spectrum seems to be a Cerenkov resonance with the lower Trivelpiece-Gould mode. It does not seem to play an important role in modifying the particle distributions. The high frequency spectrum is a Cerenkov resonance with the upper Trivelpiece-Gould mode. It is responsible for the major perturbation of the beam energy in BPD.

21943 **Diffusion in a quiet plasma and enhanced heating and diffusion in a turbulent plasma.** Okubo, M.K. Irvine, CA; Univ. of California (1986). 153p. University Microfilms Order No. 86-26,841.

Thesis (Ph. D.).

Cross-field ion transport was examined when ion-ion collisions played a significant role. Direct measurements of the test-particle diffusion of ions were made using a nonperturbing laser induced fluorescence diagnostic, and diffusion coefficients were compared with classical collisional diffusion predictions. Ion heating due to the parametric decay of lower hybrid waves (LHW) into electrostatic ion-cyclotron waves (EICW) was studied and the resulting effects on ion diffusion were examined. The experimental results were compared with predictions of ion-heating theory and with theories of enhanced diffusion due to turbulence in a plasma. The diffusion coefficient measured in a quiet plasma was found to agree, in magnitude and in scaling with B field and density, with that of diffusion driven by ion-ion collisions. It was found that, above a threshold wave power, diffusion driven by turbulent EICW could dominate the collisional contribution. The measured heating caused by turbulent EICW agreed with that derived from the kinetic theory of turbulent plasmas. Modulation of the pump LHW increased the ion heating over that with an equivalent CW pump. Peaks in heating at LHW modulation frequencies near the EICW frequencies showed resonant interactions between the resulting low-frequency beat waves and the original parametric-decay EICW. Modulation of the LHW increased ion heating by as much as a factor of two over that of the CW pump LHW.

21944 **Optical diagnostic study of the ion dynamics in a simple axisymmetric magnetic mirror stability, heating, and confinement.** Good, T.N. Irvine, CA; Univ. of California (1986). 279p. University Microfilms Order No. 86-26,832.

Thesis (Ph. D.).

This thesis describes a series of experimental investigations of ion dynamics in a simple axisymmetric magnetic mirror. Experiments were performed in a low $\beta$, quiescent plasma that was produced by contact ionization of an alkaline earth metal vapor on a thermionically emitting, rhenium hot plate. A barium plasma was chosen in order to facilitate the optical diagnosis of the ion velocity distribution function by laser-induced fluorescence. The plasma source was positioned at one magnetic field maximum. Adiabatic flow of plasma along flaring magnetic field lines was studied. Ion bulk parameters of temperature, drift velocity, and density were determined from the measurements of the velocity distribution function under conditions of variable mirror ratio. Methods of producing a mirror trapped ion distribution were explored. Ions were heated by plasma wave-particle resonant interactions. Two methods were employed: ion heating by broadband lower hybrid waves and ion cyclotron resonance heating. In order to destabilize the mirror confined plasma to the magnetic curvature induced interchange instability, an electrostatic gate was utilized to insulate the plasma from the stabilizing influence of the source.

21945 **Excitation and the propagation of ion acoustic solitons in nonideal plasmas.** Chang, H.Y. Iowa City, IA; Univ. of Iowa (1986). 98p. University Microfilms Order No. 86-28,086.

Thesis (Ph. D.).

Ion-acoustic soliton propagation in non-ideal plasmas is investigated experimentally and theoretically by modifying the KdV equation and/or using the Kadomstev-Petviashvili (KP) equation. The evolution of the frequency spectrum of a velocity modulated bursts of ions from a fine mesh grid in a plasma is measured and interpreted. Experiments on the propagation of an ion-acoustic soliton into a region of inhomogeneous plasma density are described. It is found that the local amplitude and velocity decrease and the width increases as the soliton propagates into a region of lower density. The propagation of an ion-acoustic soliton from a quiescent plasma region into a localized nonquiescent region is experimentally examined. The soliton properties are preserved although the soliton undergoes an enhanced damping as it propagates in the noisy plasma. The effects of small transverse perturbations are studied by launching solitons from the nonplanar geometries and interpreted using the KP equation.

**21946 Trapped electron transport via microinstabilities.** Hu, Y. Princeton, NJ; Princeton Univ. (1986). 87p. University Microfilms Order No. 86-26,169.

Thesis (Ph. D.).

Anomalous electron thermal conduction is generally recognized to be the principal heat loss channel in most modern tokamaks. Turbulent drift type microinstabilities have long been suspected to be the primary cause of this anomalous thermal conduction. In this work, a systematic formulation of trapped-electron transport is presented, based on a drift-wave turbulence model in the good confinement region (between the $q = 1$ and $q = 2$ surfaces). A pre-existing nonlinear gyrokinetic formalism was extended to include collisional effects by using the Fokker-Planck collision operator. Following the procedures of neoclassical theory, a formal transport theory including turbulence is developed. To further explore the properties of the low-$\beta$ gyrokinetic Fokker-Planck equation, the author considers the specific case of an axisymmetric, large aspect ratio tokamak with circular, concentric magnetic surfaces and employs the ballooning mode representation for the fluctuating quantities. The resulting equation is solved analytically for the perturbed electron distribution function. Corresponding expressions for the fluxes of particles and energy are evaluated numerically after prescribing the mode structure along the field line and the saturated mode amplitudes. Electrostatic transport coefficients thus obtained are presented and found to be in agreement with previous heuristic arguments.

**21947 Aspects of turbulent transport in a bounded plasma.** Smith, R.A. Princeton, NJ; Princeton Univ. (1986). 121p. University Microfilms Order No. 86-26,197.

Thesis (Ph. D.).

A new approach to the problem of turbulent transport in plasmas is formulated, based upon the constraints imposed by boundary conditions and conservation laws. This approach is consistent with several recent phenomenological studies of global confinement scalings in magnetically confined fusion plasmas. It implies that the edge regions of such configurations are particularly important in determining fluxes of particles and thermal energy. A general method for studying turbulent transport from this point of view is elaborated. The method is applied to a simple model, which shares some salient features with the fluctuations that account for transport in the edge regions of experimental plasmas; these features include wavelike behavior on large scales and a self consistent relation between mean quantities and the fluctuations in dynamic equilibrium. A mixing length analysis is presented, based upon these general properties and a small number of additional physical assumptions. The mixing length theory, which accounts for phase relations, transport, and the mean density gradient in the nonlinear state, emphasizes the balance between turbulent and classical transport mechanisms in the edge region. It requires input from a weakly nonlinear theory, which is developed in the form of a rigorous bifurcation analysis.

**21948 Radiation from nonlinear coupling of plasma waves.** Fung, S.F. College Park, MD; Univ. of Maryland (1986). 212p. University Microfilms Order No. 86-25,678.

Thesis (Ph. D.).

The author examines the generation of electromagnetic radiation by nonlinear resonant interactions of plasma waves in a cold, uniformly magnetized plasma. In particular, he considers the upconversion of two electrostatic wave packets colliding to produce high frequency electromagnetic radiation. Efficient conversion of electrostatic to electromagnetic wave energy occurs when the pump amplitudes approach and exceed the pump depletion threshold. Results from the inverse scattering transform analysis of the three-wave interaction equations are applied. When the wave packets are initially separated, the fully nonlinear set of coupling equations, which describe the evolution of the wave packets, can be reduced to three separate eigenvalue problems; each can be considered as a scattering problem, analogous to eh Schroedinger equation. In the scattering space, the wave packet profiles act as the scattering potentials. When the wavepacket areas approach (or exceed) $\pi/2$, the wave functions are localized (bound states) and the scattering potentials are said to contain solitons. Exchange of solitons occurs during the interaction. The transfer of solitons from the pump waves to the electromagnetic wave leads to pump depletion and the production of strong radiation. The emission of radio waves is considered by the coupling of two upper-hybrid branch wave packets, and an upper-hybrid and a lower hybrid branch wave packet.

**21949 Current drive by asymmetrical heating in a toroidal plasma.** Gahl, J.M. Lubbock, TX; Texas Tech Univ. (1986). 106p. University Microfilms Order No. 86-27,666.

Thesis (Ph. D.).

This report describes the first experimental observation of current generation by asymmetrical heating of ions. A unidirectional fast Alfven wave launched by a slow-wave antenna inside the Texas Tech Tokamak, asymmetrically heated the ions. Measurements of the asymmetry of the toroidal plasma current with probes at the top and bottom of the toroidal plasma column confirmed the current generation indirectly. Current generation, obtained in a one-species, hydrogen plasma, is a phenomenon which had not been predicted previously. Calculations of the dispersion relation for the fast Alfven wave near the fundamental cyclotron resonance in a one-species, hydrogen plasma, using warm plasma theory, support the experimental results.

**21950 Alfven wave heating in the ideal MHD and Guiding Center Plasma models.** Kalfaoglu-Divringi, L.R. New Haven, CT; Yale Univ. (1986). 194p. University Microfilms Order No. 86-28,046.

Thesis (Ph. D.).

Plasma heating through resonant absorption of Alfven waves is studied within the framework of the ideal MHD and Guiding Center Plasma models. The heating procedure is applied to a plasma in a steady state equilibrium in a one-dimensional slab surrounded by vacuum regions on both sides. First, the well-established ideal MHD model is reviewed. In the presence of an external excitation, the equation for the displacement of the plasma from its equilibrium position is presented along with the appropriate boundary conditions and corresponding energy absorption rate. Later, the similar calculations are done in the Guiding-Center Plasma model, where the controversial assumptions of adiabaticity and implicit large collisionality of ideal MHD are dropped and the stress tensor is allowed to be anisotropic. A one dimensional gyrokinetic equation is utilized to find the gyrokinetic distribution function. Moments of this distribution function are calculated to find the stress tensor which is then inserted into MHD equations to obtain an ordinary differential equation for the displacement of the plasma. It is found that the cusp resonance of ideal MHD has disappeared and that another resonance continuum depending on the plasma dispersion relation has appeared in this model. Finally, a numerical code is developed for both models and results are compared.

**21951 Fast wave propagation and minority ion heating current drive in a two ion species tokamak plasma.** Wong, K.L.,. Lubbock, TX; Texas Tech Univ. (1986). 82p. University Microfilms Order No. 86-27,663.

Thesis (Ph. D.).

Local cavity resonances of fast waves in a two ion species tokamak plasma and current generation due to the asymmetric cyclotron heating of minority ions by fast waves were investigated. Experimental results demonstrate the existence of a local cavity resonance for fast waves propagating in a deuterium tokamak plasma with a low concentration (5%) of hydrogen minority ions. The local resonance cavity for the fast waves is formed by the hybrid cutoff layer and the outer wall. Current generation by asymmetric minority heating with no net momentum injection into the plasma is studied numerically by solving the Fokker-Planck equation in which the quasi-linear diffusion term for cyclotron absorption is added to the Coulomb collision terms. Results show that the current drive efficiency is better in a hydrogen-deuterium plasma than a $He^3$-deuterium plasma. Applicability of the minority ion heating current drive scheme in a hydrogen tokamak plasma with unavoidable impurity ions as the minority ions is investigated. The practicality of this current drive process for fusion reactors is also discussed.

21952 **Summary abstract: laser-induced fluorescence of metal-atom impurities in a neutral beam.** Burrell, C.F.; Pyle, R.V.; Sabetimani, Z.; Schlachter, A.S. (Lawrence Berkeley Lab., CA). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 3: No. 3, 1089-1090(May-Jun 1985). Contract AC03-76SF00098.

The need to limit impurities in fusion devices to low levels is well known. They have investigated, by the technique of laser-induced fluorescence, the concentration of heavy-metal atoms in a neutral beam caused by their evaporation from the hot filaments in a conventional high-current multifilament hydrogen-ion source.

21953 **Probes for plasma edge diagnostics in magnetic confinement fusion devices.** Manos, D.M.; McCracken, G.M. (Princeton Plasma Physics Lab., Princeton Univ NJ). pp 135-209 of Physics of plasma-wall interactions in controlled fusion. Post, D.R.; Behrisch R. New York, Ny; Plenum Press (1984). (CONF-8407172—).

From NATO advanced study institute on physics of plasma-wall interactions in controlled fusion; Val-Morin, Quebec, Canada (30 Jul 1984).

This paper examines probes used in fusion devices to measure edge plasma parameters. Electrical probes and surface collector probes lare described which can provide useful data and the two techniques are largely complementary. Energy analyser are included among the electrical probes and long term probes placed on the walls for extended periods are included in the surface probes. Methods of measuring erosion and redeposition are also outlined. Some of the problems inherent in probes such as disturbance of the plasma and practical problems of construction are discussed.

21954 **Plasma transport near material boundaries.** Singer, C.E. (Plasma Physics Lab., Princeton Univ., Princeton, NJ). pp 607-625 of Physics of plasma-wall interactions in controlled fusions. Post, D.E.; Behrisch, R. New York, NY; Plenum Press (1984). (CONF-8407172—).

From NATO advanced study institute on physics of plasma-wall interactions in controlled fusion; Val-Morin, Quebec, Canada (30 Jul 1984).

The fluid theory of two-dimensional (2-d) plasma transport in axisymmetric devices if reviewed. These models are beginning to play an important role in the design and interpretation of tokamak experiments. Emphasis is placed on understanding the conditions under which the known 2-d plasma fluid equations provide a valid description of these processes. Attempts to extend the fluid treatment to less collisional, turbulent plasmas are discussed. The complete 1-d fluid equations are given in the text, and 2-d fluid equations are given in the Appendix.

21955 **Plasma models for impurity control experiments.** Post, D.E.; Lackner, K. (Plasma Physics Lab., Princeton Univ., N.J.). pp 627-693 of Physics of plasma-wall interactions in controlled fusions. Post, D.E.; Behrisch, R. New York, NY; Plenum Press (1984). (CONF-8407172—).

From NATO advanced study institute on physics of plasma-wall interactions in controlled fusion; Val-Morin, Quebec, Canada (30 Jul 1984).

this paper outlines some of the various models used for calcualting plasma edge conditions, and discusses a few of the numerical techniques used for both hydrogen and impurity transport. The present state of scrape-off layer modeling is far less satisfactory for impurities than for the background plasma, an impression that is further enhanced when a comparison with experiments is attempted.

21956 **Neutral Particle transport.** Heifetz, D.B. (Princeton Plasma Physics Lab., Princeton, NJ). pp 695-771 of Physics of Plasma-wall interactions in controlled fusions. Post, D.E.; Behrisch, R. New York, NY; Plenum Press (1984). (CONF-8407172—).

From NATO advanced study institute on physics of plasma-wall interactions in controlled fusion; Val-Morin, Quebec, Canada (30 Jul 1984).

The effects of neutral transport, which is the transport of mass, momentum, and energy in a plasma by neutral atoms and molecules, are discussed. The physics of neutral transport and complete neutral trasport codes are examined. The Boltzmann equation and the one-dimensional Boltzmann equation as an analytic solution is described; Monte Carlo solutions are also given. Variance reduction techniquesa re discussed and samples applications are described.

21957 **Application of advanced millimeter/far-infrared sources to collective Thomson scattering plasma diagnostics.** Woskoboinikow, P.; Cohn, D.R.; Temkin, R.J. (Massachusetts Institute of Technology, Cambridge). *International Journal of Infrared and Millimeter Waves;* 4: No. 2, 205-229(1983).

The application of advanced millimeter/far infrared sources to substantially improve the effectiveness of collective Thomson scattering plasma diagnostics is discussed. Gyrotrons, $CO_2$ lasers and far infrared lasers which are optically pumped with $CO_2$ laser radiation can now provide important new capabilities in terms of combined high peak power and high average power, fine frequency tunability and a wide range of operating frequencies. Their capabilities can improve the signal to noise ratio and make possible time dependent scattering measurements. Both thermal level scattering used for determination of ion temperature and low level non-thermal measurements used for the investigation of plasma turbulence and wave phenomena are considered. Rapidly pulsed gyrotrons, $CO_2$, and optically pumped lasers can provide a range of combinations of high peak power and high energy during a given time interval. The use of this high peak power - high energy trade off capability to maximize signal to noise ratios is discussed. Dramatic reduction in stray light, using fine frequency source tunability and gas absorption cell technology, is also discussed.

## 7002 Fusion Power Plant Technology

*REFER ALSO TO CITATION(S) 20532, 20540, 20541, 20542, 20543, 20544, 20546, 20548, 20629, 20638, 20856, 21439, 21625, 21877, 21953, 21953, 21954, 21955, 21955, 21956, 22064*

21958 **(AD-A—175336/7/XAB) Variation in the amplitude of perturbations on the inner surface of an imploding shell during the coasting phase. Memorandum report, September 1985-June 1986.** Book, D.L.; Bodner, S.E. (Naval Research Lab., Washington, DC (USA)). 10 Nov 1986. 25p. (NRL-MR—5892). NTIS, PC A02/MF A01.

In some inertial-confinement fusion-target designs, a spherical shell collapses on a void or compresses a small amount of gaseous material. There can be a period during which both the outside (driver) pressure and the inside pressure have a negligible effect on the implosion dynamics, and the motion is essentially ballistic. The changes in the aspect ratio occur mainly because of geometrical convergence. For reasonable parameters, the inner surface does not begin to decelerate until shortly before convergence is complete. An approximate description of this casting phase is developed and to study the evolution of perturbations on the inner and outer surfaces of the shell in the limit where the fluid is incompressible. The two surfaces are strongly coupled as long as the shell remains thin. When the shell becomes thick compared to the inner radius, the inner and outer surface perturbations decouple. Under these conditions the surface wave action is a good adiabatic invariant, which can be used to estimate the change in the amplitude of a perturbation as a function of the shell inner radius R1. Detailed analysis confirms the adiabatic invariance argument and extends the results. We speculate that the adiabatic invariant may also be good in the case of compressible fluids.

21959 **(ANL/FPP/TM—208) Design analyses of self-cooled liquid metal blankets.** Gohar, Y. (Argonne National Lab., IL (USA)). Dec 1986. Contract W-31109-ENG-38. 50p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005583.

A trade-off study of liquid metal self-cooled blankets was carried out to define the performance of these blankets and to determine the potential to operate at the maximum possible values of the performance parameters. The main parameters considered during the course of the study were the tritium breeding ratio (TBR), the blanket energy multiplication factor, the energy fraction

lost to the shield, the lithium-6 enrichment in the breeder material, the total blanket thickness, the reflector material selection, and the compositions of the different blanket zones. Also, a study was carried out to assess the impact of different reactor design choices on the reactor performance parameters. The design choices include the impurity control system (limiter or divertor), the material choice for the limiter, the elimination of tritium breeding from the inboard section of tokamak reactors, and the coolant choice for the non-breeding inboard blanket. In addition, tritium breeding benchmark calculations were performed using different transport codes and nuclear data libraries. The importance of the TBR in the blanket design motivated the benchmark calculations.

21960 **(CONF-860917—14) BEATRIX: The international breeder materials exchange.** Johnson, C.E.; Reuther, T.C.; Dupouy, J.M. (Argonne National Lab., IL (USA); Department of Energy, Washington, DC (USA). Office of Fusion Energy; Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). NET Design Team). 1986. Contract W-31109-ENG-38. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87004668.

From 14. SOFT - symposium on fusion technology; Avignon, France (8 Sep 1986).

The BEATRIX experiment is an IEA-sponsored effort that involves the exchange of solid breeder materials and shared irradiation testing among research groups in several countries. The materials will be tested in both closed capsules (to evaluate material lifetime) and opened capsules (to evaluate purge-flow tritium recovery). Pre- and post-irradiation measurement of thermophysical and mechanical properties will also be carried out.

21961 **(CONF-861175—1) Progress in stellarator/heliotron research, 1981-1986.** Lyon, J.F. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 45p. NTIS, PC A03. File Number DE87005505.

From IAEA workshop on the stellerator heliotron; Kyoto, Japan (25 Nov 1986).

Viewgraphs from this presentation are included. (MOW)

21962 **(CONF-861175—3-Vugraphs) Low-aspect-ratio torsatron reactors and ATF-II studies.** Lyon, J.F. (Oak Ridge National Lab., TN (USA)). Nov 1986. Contract AC05-84OR21400. 34p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005506.

From IAEA workshop on the stellerator heliotron; Kyoto, Japan (25 Nov 1986).

Viewgraphs from this presentation are included. (MOW)

21963 **(CONF-861175—4-Vugraphs) Assessment and control of error fields for ATF.** Harris, J.H.; Lee, D.K.; Colchin, R.J.; Anderson, F.S.B. (Oak Ridge National Lab., TN (USA); Wisconsin Univ., Madison (USA)). 1986. Contract AC05-84OR21400. 22p. NTIS, PC A02. File Number DE87005690.

From IAEA workshop on the stellerator heliotron; Kyoto, Japan (25 Nov 1986).

Viewgraphs presented at the meeting are included. (MOW)

21964 **(CONF-861254—1) The regional electromagnetics workshop in the USA.** Turner, L.R. (Argonne National Lab., IL (USA)). Nov 1986. Contract W-31109-ENG-38. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004709.

From International workshop for eddy current code comparison; Tokyo, Japan (20 Dec 1986).

At the Second Regional Workshop, held at Argonne National Laboratory 23 to 24 June 1986, fifteen participants from four countries heard ten presentations on Problems 1, 2, and 6. This note includes information about the workshop and summaries of the results for Problems 1 and 2.

21965 **(CONF-8609157—2) Thermal conductivity of fusion solid breeder materials.** Liu, Y.Y.; Tam, S.W. (Argonne National Lab., IL (USA)). Jun 1986. Contract W-31109-ENG-38. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004663.

From International workshop on the properties of ceramics and their measurements; Soverato, Italy (22 Sep 1986).

Several simple and useful formulae for estimating the thermal conductivity of lithium-containing ceramic tritium breeder materials for fusion reactor blankets are given. These formulae account for the effects of irradiation, as well as solid breeder configuration, i.e., monolith or a packed bed. In the latter case, a coated-sphere concept is found more attractive in incorporating beryllia (a neutron multiplier) into the blanket than a random mixture of solid breeder and beryllia spheres.

21966 **(CONF-8610115—22) Accelerated beam experiments with the ORNL SITEX [Surface Ionization with Transverse Extraction] and VITEX [Volume Ionization with Transverse Extraction] $H^-/D^-$ sources.** Dagenhart, W.K.; Tsai, C.C.; Stirling, W.L.; Ryan, P.M.; Schechter, D.E.; Whealton, J.H.; Donaghy, J.J. (Oak Ridge National Lab., TN (USA); Washington and Lee Univ., Lexington, VA (USA)). 1986. Contract AC05-84OR21400. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005683.

From 4. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (27 Oct 1986).

Beam parameters have been measured for both the Surface Ionization with Transverse Extraction (SITEX) and Volume Ionization with Transverse Extraction (VITEX) $H^-/D^-$ ion sources. Both sources use a reflex discharge to generate the main plasma. Beam energies up to 18 keV were used for pulse lengths up to several seconds. For SITEX, Faraday cup magnetically analyzed $D^-$ beam currents of 110 mA at extraction densities of 48 $mA/cm^2$ and at a source ion temperature of 4 eV have been measured. For the VITEX results, Faraday cup magnetically analyzed beam currents of up to 80 mA at extraction densities of 27 $mA/cm^2$ and at a source ion temperature of 0.5 eV have been measured. Virtually all extracted electrons were recovered at an energy of 10 to 30% of the accel beam energy, and there were none in the analyzed beam.

21967 **(CONF-8610214—2) Oxidation of tritium atoms at a stainless steel surface.** Finn, P.A.; VanDeventer, E.H. (Argonne National Lab., IL (USA)). Oct 1986. Contract W-31109-ENG-38. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004936.

From International symposium on fusion reactor blanket and fuel cycle technology; Tokai-mura, Japan (27 Oct 1986).

The dynamic reaction of oxygen and tritium on a stainless steel surface was studied for low oxygen concentrations (less than 1 ppM oxygen in helium). The oxygen was swept over a stainless surface through which 20 to 90 $\mu Ci/d$ of tritium permeated. Dynamic conditions were maintained for three to five days with gas flow rates maintained at 40 to 100 mL/min. The ratio between the tritiated water collected and the tritium gas collected was less than one. At oxygen levels greater than 50 ppM, the ratio of tritiated water to tritium gas appears to be greater than 10.

21968 **(CONF-8610214—4) The LISA-1 and TRIO in-pile tests.** Clemmer, R.G.; Werle, H.; Briec, M. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.); CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France)). 27 Oct 1986. Contract W-31109-ENG-38. 5p. NTIS, PC A02. File Number DE87004957.

From International symposium on fusion reactor blanket and fuel cycle technology; Tokai-mura, Japan (27 Oct 1986).

The in-pile tests TRIO and LISA-1 involve measurement of in-situ tritium release as a function of time, temperature and sweep gas conditions. These in-situ tritium recovery experiments are similar in concept to other in-pile tests such as the VOM series, Exotic, and the LILA series. TRIO used a single capsule with lithium aluminate. The results from TRIO have been compiled, evaluated and reported. The LISA-1 experiment had six test capsules: one lithium aluminate, one lithium orthosilicate ($Li_4SiO_4$), and four lithium metasilicate ($Li_2SiO_3$). A previous report gives a description of the experimental setup, experimental observations, and preliminary results. Presented herein is a more detailed evaluation of the LISA-1 experimental results for the three breeder materials. The results from LISA are then compared to those of TRIO.

21969 **(CONF-8610240—1) Experimental study of coupling between eddy currents and deflections in cantilevered beams as models of tokamak limiters.** Turner, L.R.; Hua, T.Q. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004938.

From IUTAM conference: electromagnetomechanical interactions in deformable solids and structures; Tokyo, Japan (12 Oct 1986).

The coupling between eddy current and motion in a cantilevered beam is examined. The beam, which provides a simple model for the limiter blades of a tokamak fusion reactor, was subjected to simultaneous orthogonal time-varying and constant magnetic fields. The dynamic deformation of the beam includes two different modes: a bending mode and a torsional mode. Interaction of current with each mode and with the combined modes of vibration in described. Experimental verification of the case without torsional motion was performed with the FELIX facility at ANL. The peak deflection and stresses are much less than those predicted without consideration given to the coupling.

21970 **(DOE/DP/40200—24-Vol.26) LLE [Laboratory for Laser Energetics] review: Quarterly report, January-March 1986.** Schmid, A. (ed.). (Rochester Univ., NY (USA). Lab. for Laser Energetics). 1986. Contract FC08-85DP40200. 64p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87005865.

This volume of the LLE Review contains reports on OMEGA and GDL laser activities; characterization of laser-generated x-ray sources for nuclear level excitation; the physics of parametric instabilities driven by two pump beams in laser-produced plasmas; developments in advanced technology areas at LLE, specifically ultra-high-speed opto-electronic devices and methods and the modeling of thin-film features in physical vapor deposition; and the National Laser Users Facility activities from January to March 1986. The following are highlights of articles contained in this issue: (1) Parametric instabilities driven by more than one laser beam are analyzed for realistic laser-driven plasmas. (2) OMEGA laser-plasma x-ray yields are analyzed for their suitability in pumping novel γ-ray laser configurations. (3) A new streak spectrograph combines an x-ray streak camera with a conically curved crystal x-ray spectrograph for time-resolved spectral analysis of laser-plasma x rays. (4) The race for the fastest device switching times among high-speed electronic circuits is accelerated by the LLE opto-electronic sampling technique, which measured a 5-ps rise time in a permeable-base transistor. (5) Growth abnormalities in physically vapor-deposited optical thin films are a vexing problem for film environmental stability and high-power laser compatibility.

21971 **(DOE/DP/40200—30) Target fabrication for high density target experiments at the University of Rochester's Laboratory for Laser Energetics.** Kim, H.; Soures, J.M. (Rochester Univ., NY (USA). Lab. for Laser Energetics). 1986. Contract FC08-85DP40200. 8p. (CONF-860330—3). NTIS MF A01; 2; GPO Dep. File Number DE87005915.

From 5. annual target fabrication specialists meeting; Las Vegas, NV, USA (24 Mar 1986).

A theoretical and experimental program is in progress at the University of Rochester's Laboratory for Laser Energetics to demonstrate high density compression using the 351-nm, uniform illumination, OMEGA laser facility. The targets that have the best chance of meeting the objectives of this campaign are low-Z polymer shells with liquid or solid DT layers. This paper describes fabrication activities of such targets. These activities include polymer shell fabrication, development of a cryogenic fuel facility, a tritium filling facility, development of low-mass target supports, and development of levitated target coating.

21972 **(DOE/DP/40200—31) Direct-drive laser-fusion in the US.** McCrory, R.L.; Soures, J.M.; Audebert, P.; Barnouin, O.; Craxton, R.S.; Delettrez, J.; Epstein, R.; Forsley, L.; Hutchison, R.J.; Jacobs, S. (Rochester Univ., NY (USA). Lab. for Laser Energetics; Naval Research Lab., Washington, DC (USA); International Atomic Energy Agency, Vienna (Austria)). 1986. Contract FC08-85DP40200. 9p. (IAEA-CN—47/B-I-5; CONF-861106—21). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005916.

From IAEA international conference on plasma physics and controlled nuclear fusion research; Kyoto, Japan (12 Nov 1986).

Direct-drive experiments at the University of Rochester's Laboratory for Laser Energetics (LLE) and the Naval Research Laboratory (NRL) are presently addressing issues in pellet compression and heating: efficiency of coupling of laser energy to the target and the coupling of absorbed energy to the fuel, drive uniformity, hydrodynamic stability, preheat arising from laser plasma instabilities and x-rays, and target diagnostics. The 24-beam, 2500-Joule, 351 nm OMEGA laser system at LLE has been used in an experimental effort to achieve high compressed DT fuel densities. Detailed hydrodynamic computer simulations at NRL predict that the growth rate of the ablative Rayleigh-Taylor instability is less than the classical values. Recent Rayleigh-Taylor experiments ar NRL are testing these predictions.

21973 **(DOE/DP/40200—32) Thermal self-focusing with multiple beams.** Craxton, R.S.; McCrory, R.L. (Rochester Univ., NY (USA). Lab. for Laser Energetics). Jul 1986. Contract FC08-85DP40200. 21p. (CONF-8607116—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005917.

From 16. annual anomalous absorption conference; Lake Luzerne, NY, USA (13 Jul 1986).

Self-focusing in underdense plasmas in the presence of overlapping beams is of interest for multibeam laser-irradiation systems. The hydrodynamics/ray-tracing simulation code SAGE is used to model thermal self-focusing in two-dimensional line-focus geometry with beams incident obliquely at different angles. The conjecture that multiple overlapping beams may suppress self-focusing is investigated for parameters appropriate to reactor-sized targets; in particular, the dependence upon intensity, scale length and pulse width is examined. While the full problem is three-dimensional, insight may be gained from two-dimensional simulations.

21974 **(DOE/DP/40200—45) High power laser research and development at the Laboratory for Laser Energetics.** Soures, J.M.; McCrory, R.L.; Cerqua, K.A.; Craxton, R.S.; Hutchison, R.; Jacobs, S.D.; Kessler, T.; Kelly, J.; Mourou, G.; Seka, W. (Rochester Univ., NY (USA). Lab. for Laser Energetics). 1986. Contract FC08-85DP40200. 14p. (CONF-8609127—18). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005921.

From SPIE's fiber LASE '86; Cambridge, MA, USA (14 Sep 1986).

As part of its research mission - to investigate the interaction of intense radiation with matter - the Laboratory for Laser Energetics (LLE) of the University of Rochester is developing a number of high-peak power and high-average-power laser systems. In this paper we highlight some of the LLE work on solid-state laser research, development and applications. Specifically, we discuss the performance and operating characteristics of Omega, a twenty-four beam, 4000 Joule, Nd:glass laser system which is frequently tripled using the polarization mismatch scheme. We also discuss progress in efforts to develop high-average-power solid-state laser systems with active-mirror and slab geometries and to implement liquid-crystal devices in high-power Nd:glass lasers. Finally we present results from a program to develop a compact, ultrahigh-peak-power solid-state laser using the concept of frequency chirped pulse amplification.

21975 **(DOE/DP/40211—1) Thermal transport studies using extreme ultraviolet spectroscopy: Final report for the period 31 August 1984-1 January 1986.** Griem, H.R. (Maryland Univ., College Park (USA). Lab. for Plasma and Fusion Energy Studies). Dec 1986. Contract AS08-84DP40211. 26p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005040.

In view of the crucial importance of thermal transport for the hydrodynamic efficiency of inertial fusion, a complementary approach to the well established x-ray method for burnthrough measurements had been proposed using longer wavelength lines. Basically, this will allow access to a lower temperature region, possibly including some preheat. As proposed, a theoretical program was initiated to enhance the University of Rochester computer code by adding the various atomic processes needed to calculate quantitatively lithium-like line spectra. We contributed to the University of Rochester program through our various tests of atomic physics packages in LILAC. In April 1986, successful measurements were made for aluminum and titanium targets overcoated with up to 9 to 11 μm, respectively, of CH. A description of these measurements and of the conclusions reached by comparison with the code simulation constitutes the bulk of this report.

21976 (EUR-CEA-FC—1295, pp 21-24) **Scrape-off layer and coupling studies with the 3.7 GHz 18-waveguide multijunction grill on Petula.** Goniche, M.; David, C.; Tonon, G.; Rey, G.; Briand, P. (Association EURATOM-CEA, CEN Grenoble, 38, France. Dept. de Recherches sur la fusion controlee). May 1986. NTIS (US Sales Only), PC A04/MF A01. File Number DE87751062. (CONF-860412—Pt.1).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

A 500 kW-30 ms-3.7 GHz L.H. experiment has been operated on Petula in order to test the physical and technical options taken for the Lower Hybrid system of TORE SUPRA. The antenna used to launch the wave to the plasma is a modular 18-waveguide grill using mainly the multijunction effect. This provides a great simplification of the antenna, but the 6 waveguides of a module are tightly RF coupled. This paper presents the RF behaviour of such an antenna: self-matching properties of the multijunction, plasma R.F. wave coupling. These studies have been supported by scrape-off layer density measurements before and during the RF pulses.

21977 **(EUR-CEA-FC—1297) Generalized network representation of twist-reflectors.** Rebuffi, L. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). Jun 1986. 36p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751050.

A general network representation of different kinds of Twist-Reflector (TR) is presented. By mean of a TM- and TE-type modal representation of the fields, using a double equivalent circuit it is possible to describe a strip, parallel plate or corrugated surface T.R. Modal reflection coefficients GAMMA' and GAMMA'' are derived starting from Marcuvitz formulations [1 ] and adapting them to different tested mirrors. Theoretic-empirical circuit parameters are thus deduced to satisfy the two basic conditions for an optimal design. The strip and the plate thickness is considered to be finite, thus reducing the degree of approximation. Using this model, predicted theoretical values for the reflector efficiency are in close agreement with experimental results, thus permitting a correct design of different kinds of Twist-Reflector.

21978 **(GA-A—18418) Initial conditioning of the vessel wall and the graphite limiters in DIII [Doublet III]-D.** Brooks, N.H.; Petersen, P. (GA Technologies, Inc., San Diego, CA (USA)). Jun 1986. Contract AC03-84ER51044. 22p. (CONF-860522—23). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005237.

From 7. international conference on plasma surface interactions in controlled fusion devices; Princeton, NJ, USA (5 May 1986).

The Doublet III tokamak has been rebuilt to accommodate in a single device both large dee-shaped limiters and single-null divertor plasmas (a = 0.67 m) with high elongation (b/a ≧ 2). The new vacuum vessel has been conditioned by a combination of 400°C baking, Taylor pulsed discharge cleaning (TDC), and rf-assisted glow cleaning (RGC). Tokamak operation began in February 1986 with an 0.5 MA discharge produced on the first day plasmas were attempted. Rapid achievement of high current (I ≧ 2.5 MA) tokamak discharges in the DIII-D device underscores the importance of high temperature bakeout in shortening the initial cleanup period for a vessel with large amounts of graphitic armor.

21979 **(GTFR—70) The sputtering and redeposition behaviour of $VBe_{12}$ compound and of Ti-Cu-Li composites within a fusion tokamak environment.** DeWald, A.B. Jr.; Brooks, J.N.; Krauss, A.R.; Gruen, D.M. (Georgia Inst. of Tech., Atlanta (USA). Fusion Research Center; Argonne National Lab., IL (USA)). Jan 1987. Contract AS05-78ET52025. 20p. NTIS, PC A02. File Number DE87005315.

$VBe_{12}$ compound and porous titanium composites infiltrated with a lithium bearing copper alloy have been investigated as a means of reducing fusion plasma impurities and sputter erosion associated with fusion tokamak limiter and divertor surfaces. These materials possess high temperature strength and melt-layer stability properties in conjunction with the self-sustainment of a low-Z overlayer that inhibits erosion of the underlying structural substrate. The sputter erosion and redeposition properties of these materials have been analyzed by calculating the sputtering coefficients via TRIM, which are subsequently used in the REDEP code to evaluate their performance for various plasma edge temperature regimes. The results have been compared to elemental beryllium, tungsten, and graphite on the basis of minimizing plasma impurities and material erosion, suppressing runaway self-sputtering, and/or enhancing thermal properties.

21980 **(HEDL-TME—86-13) Test results of lithium pool-air reaction suppression systems.** Jeppson, D.W. (Hanford Engineering Development Lab., Richland, WA (USA)). Feb 1987. Contract AC06-76FF02170. 117p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87006603.

Engineered reaction suppression systems were demonstrated to be effective in suppressing lithium pool-air reactions for lithium quantities up to 100 kg. Lithium pool-air reaction suppression system tests were conducted to evaluate suppression system effectiveness for potential use in fusion facilities in mitigating consequences of postulated lithium spills. Small-scale perforated and sacrificial cover plate suppression systems with delayed inert gas purging proved effective in controlling the lithium-air interaction for lithium quantities near 15 kg at initial temperatures up to 450°C. A large-scale suppression system with a sacrificial cover, a diverter plate, an inert gas atmosphere, and remotely retrievable catch pans proved effective in controlling lithium pool-air interaction for a 100-kg lithium discharge at an initial temperature of 550°C. This suppression system limited the maximum pool temperature to about 600°C less than that expected for a similar lithium pool-air reaction without a suppression system. Lithium aerosol release from this large-scale suppression system was a factor of about 10,000 less than that expected for a lithium pool-air reaction with no suppression system. Remote retrieval techniques for lithium cleanup, such as (1) in-place lithium siphoning and overhead crane dismantling, and (2) lithium catch pan removal by use of an overhead crane, were demonstrated as part of this large-scale test.

21981 (IAEA-CN—44/I-I-3, pp 403-411) **Experimental and theoretical investigations of compact toroid configurations with large-orbit particles.** Lovelace, R.V.; Fleischmann, H.H.; Jayakamar, R.; Litwin, C.; Mehanian, C.; Parker, M.R.; Seyler, E.; Sudan, R.N.; Taggart, D.P.; Turnbull, A.D. (Cornell Univ., Ithaca, NY). 1985. NTIS.

From 10. international conference on plasma physics and controlled nuclear fusion research; London, England (12-19 Sep 1984).

Experimental and theoretical progress has been made on toroidal plasma configurations (spheromaks) including an energetic, large-orbit, ion ring component. A particular advantage of the ion ring component is the stabilization of the tilt-shift modes without close-fitting metal walls, and the added flexibility of the possible reactor options of the configuration. The theory has now been devel-

oped to the point where definite stability predictions can be made on the percentage of the total current in the ion rings needed for stability as well as the optimum geometry. Experiments on the RECE-Christa device have succeeded in generating stable rings with about equal plasma and large-orbit fast electron currents.

21982 **(ILE—8508P) Suprathermal electron generation in cannonball targets.** (Osaka Univ., Suita (Japan). Inst. of Laser Engineering). Jul 1985. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700913.

Suprathermal (T/sub s/ = 20 — 300 keV) electron production in cannonball targets was investigated in Gekko laser fusion experiments. Very high temperatures (T/sub SH/ = 200 — 350 keV) and energy conversion rates (eta/sub SH/ = 10/sup -5/ - 10/sup -4/ J/J Str) were observed for the cannonball targets as compared to directly driven targets (T/sub SH/ = 20 — 200 keV, eta/sub SH/ = 10/sup -8/ — 10/sup -6/ J/J Str). Correlations of superthermal electron conversion with SRS and 3/2 ω/sub 0/ light conclusively indicated that these electrons were mainly generated by parametric processes in the region below n/sub c//4.

21983 (INIS-mf—10565, pp 38-41) **Thermal stability of cryogenic targets in laser experiments.** Koresheva, E.R.; Nikitenko, A.I. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE87780085.

Kratkie Soobshcheniya po Fizike. No. 3.

In Experimental and theoretical physics. Collection.

The problem of cryogenic target disruption in the laser thermonuclear synthesis chamber is under discussion. Estimates of target lifetime in the chamber are performed. When estimating target lifetime in a vacuum chamber with warm walls, it is necessary to consider a possibility of target disruption both at the expense of crystal growth in a DT-layer and increase of gas mass in a target center during heating. The lifetime in a chamber with Tsub(st)=300 K constitutes 0.034-0.7 s for two-layer cryogenic targets with fuel mass 3-40 μg.

21984 **(IPP—III/110) ASDEX papers at the 13th European conference on controlled fusion and plasma physics.** (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). May 1986. 149p. (CONF-860412—). NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274.

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

This report provides 29 ASDEX papers concerning pellet refuelling, confinement, high-beta plasma and MHD-equilibrium, heating by ICR, lower hybrid and current-drive, impurity studies and plasma diagnostics. All of these papers have been indexed separately.

21985 (IPP—III/110, pp 19-30) **Review on pellet fuelling.** Kaufmann, M. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching, Germany, F.R.). May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Injection of frozen hydrogen pellets was already proposed as a means of fuelling plasmas at an early stage of fusion research. After an extended period of technical development, gas gun pellet injectors are now available with speeds of up to 2000 m/s (in single-shot operation and in series of up to 7 shots per discharge). Centrifuges can deliver up to 80 pellets per discharge with speeds of up to 800 m/s. Substantial progress in understanding pellet ablation was achieved with the description of a cold gas mantle shielding the pellet against the hot plasma. For ohmic discharges with sufficiently high density, good agreement between this 'neutral shielding model' and the experimental observation of ablation was found. In the case of non-thermal electrons much faster ablation has been observed. The pellets explode at the plasma edge in extreme cases. With neutral injection part of the pellets often seems to be ablated outside the plasma. Inside the plasma enhanced ablation by fast ions has to be taken into account. For several years now a growing number of experiments with pellet injection have been conducted on hot plasmas. So far different influences on the plasma performance have been reported: Strong peaking of the density profile is usually also seen in cases where the pellet does not penetrate to the centre. In ohmic discharges with sufficient edge recycling it was observed that the averaged density increases and in parallel the particle and energy confinement are substantially improved. With growing neutral injection power, this improvement degrades, while the central particle and energy confinement remain enhanced. The peaked density profile is accompanied by a strong inward drift of high-Z material. The resulting radiation from the centre keeps the increase of the density limit below or equal to 100%.

21986 (IPP—III/110, pp 4-18) **Combined application of neutral injection, lower hybrid, and ion cyclotron resonance heating in ASDEX and synergetic effects.** Wagner, F.; Soeldner, F.X.; Steinmetz, K.; Becker, G.; Bosch, H.S.; Brocken, H.; Eberhagen, A.; Eckhartt, D.; Fussmann, G.; Gehre, O. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Confinement properties of ASDEX discharges are studied when NI and ICRH or NI and LH were applied simultaneously. ICRH leads to a larger change in plasma energy content when applied together with NI. At high power the β/sub p/-increases of NI and ICRH are additive corresponding to the total heating power. In the combination of NI and LH the β/sub p/-increase is the same when NI is applied to inductively or non-inductively driven plasma current despite the different current profiles. The effect of sawteeth on central confinement is described in detail in ohmically and beam heated plasmas as is the suppression of sawteeth by LH. The suppression of sawteeth by LH in low q/sub a/ beam heated plasmas leads to a substantial increase of β/sub p/. The H-mode can be realized with NI under current drive conditions. ICRH can cause the H-transition in combination with NI. The H-mode, however, can also be realized with ICRH alone.

21987 (IPP—III/110, pp 31-34) **Increase of the density limit in ASDEX by repetitive pellet injection.** Niedermeyer, H.; Buechl, K.; Kaufmann, M.; Lang, R.; Mertens, V.; Sandmann, W.; Becker, G.; Bosch, H.S.; Brocken, H.; Eberhagen, A. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Pellet injection is able to switch the confinement properties of a tokamak discharge fundamentally. This switching is possible with pellets penetrating to the half-radius (there are indications that even much smaller penetration depths are sufficient). Improved particle confinement and triangular density profiles permit to achieve extremely high central densities. Substantially improved energy confinement is provided in this transport regime.

21988 (IPP—III/110, pp 124-127) **Evolution of radiation power profiles in ASDEX H-mode discharges.** Mueller, E.R.; Janeschitz, G.; Smeulders, P.; Fussmann, G.; Kornherr, M.; Mast, K.F.; Becker, G.; Bosch, H.S.; Brocken, H.; Eberhagen, A. (Commission of the European Communities, Abingdon, UK. JET Joint Undertaking). May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

The paper compares the impurity radiation behaviour of two types of H-mode discharges. In the normal H-mode that reaches a quasi-stationary state the energy (and particle) losses within the outer plasma half-radius are characterized by the repetitive burst-like exhaust into the divertor and constantly moderate radiation power losses. In contrast, the burst-free variant of the H-mode with superior confinement properties is dominated by radiation losses growing continuously up to 100% of the heating power. The time evolution of the impurity concentration and the associated radiation losses at the plasma centre is hardly influenced by the kind of H-mode. If the concentration of medium-heavy metals in the burst-dominated H-mode plasma is raised to sufficiently high values, e.g. by the accumulation of intrinsic iron, the burst-free (or burst-deficient) H-mode is triggered which after a new accumulation period usually ends by a radiation collapse.

21989 (IPP—III/110, pp 128-131) **Impurity production during ICRF heating.** Janeschitz, G.; Fussmann, G.; Noterdaeme, J.M.; Steinmetz, K.; Becker, G.; Bosch, H.S.; Brocken, H.; Eberhagen, A.; Gehre, O.; Gernhardt, J. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

ICRF heating at 2Ω/sub CH/ was investigated for a variety of different target plasmas and heating regimes. In all cases a significant increase of the radiated power, caused mainly by a higher iron concentration in the plasma, is observed. Neither the moderately improved particle confinement nor a reduction of impurity screening on account of changed plasma edge parameters is responsible for the high radiation losses, but enhanced wall erosion is required to explain the experimental data. The impurity production mechanisms are not yet fully understood. Impurity sputtering by oxygen and carbon, however, could be experimentally excluded as possible production processes. In all experiments a clear anticorrelation between wave absorption and impurity production was observed. Moreover, we find that suprathermal ions are produced in the plasma edge region by the non-absorbed ICRF power. It is assumed that these particles are responsible for the excessive impurity production.

21990 (IPP—III/110, pp 132-135) **Wall carbonization in ASDEX: A collation of characteristic results.** Poschenrieder, W.; Fussmann, G.; Gierke, G. v.; Mast, F.; Niedermeyer, H.; Roth, J.; Soeldner, F.X.; Steinmetz, K.; Verbeek, H.; Wagner, F. May 1986. NTIS (US Sales Only), PC A07/MF A01. File Number DE87751274. (CONF-860412—).

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

The aim of this presentation is to describe the procedures of carbonization and decarbonization followed on ASDEX, and to summarize the most significant changes of discharge parameters observed under the various experimental conditions with carbonized walls.

21991 (IPP-JET—32) **Reemission, trapping, and desorption of implanted deuterium from JET samples.** Scherzer, B.M.U.; Boergesen, P.; Moeller, W. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). Jul 1986. 22p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751273.

Gas reemission from first-wall samples of JET was measured during 1-22 keV deuterium ion bombardment. The sample temperature was varied between room temperature and 970 K. The samples were pieces taken from the 1984-graphite limiter and 6 long-term samples (LTS) of Inconel and Ni. The near surface deuterium inventory was determined by nuclear reaction analysis (NRA). In some cases thermal desorption spectra of the implanted samples were taken. No significant differences were found between samples from different positions in the torus. Instantaneous reemission is found for low-energy (1 keV) D/sup +/-bombardment of the limiter samples due to diffusion in the deposited impurity layer. Limiter samples that have been implanted to saturation at room temperature show a release peak when further bombarded at a higher temperature. On Inconel LTS the reemission time constant tau/sub R/ is found to decrease with increasing flux. The accumulated D inventory is only partly trapped within the ion range. On Ni-LTS the deposited impurity layer undergoes a modification when the sample is heated from 250/sup 0/C to 317/sup 0/C increasing the trapped D inventory by almost two orders of magnitude.

21992 (IPPJ-DT—119) **Calorimetrical measuring system for neutral beam teststand.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Sep 1985. 18p. (In Japanese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700961.

This paper describes a small data acquisition system prepared for a beam profile measurement using a beamline calorimeter. The system is composed of an LSI-11/23 microcomputer included in a CAMAC crate and an electronic system for detecting outputs of thermocouples installed on a V-shaped calorimeter. An example of the experimental results of the beam divergence measurements is also shown.

21993 (IPPJ-DT—121) **Development of 120 keV 10 MW neutral beam teststand.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Oct 1985. 76p. (In Japanese). NTIS (US Sales Only), PC A05/MF A01. File Number DE87700962.

This is a report of design and construction of 120 keV, 10 MW Neutral Beam Test Stand (10 MW NBTS) which has been prepared for the development of NB Injector on R-project in the 1981 to 1982 fiscal year. The Test Stand is designed to simulate NBI on the project and the aim is test for the performance of many components and the over all performance of beam line. A design of the beam line (which is composed of a neutralizer cell, a 180 deg deflection magnet, calorimeter, and ion dump, etc.), 1/4 size ion source, power supply system, and sequence and control are described, and the test results are also given briefly. Main features of the NBTS are as follows: (1) A powerful ion source of 120 keV, 75 A for 1 sec, (2) Gate Turn Off (GTO) accel power supply system of 120 keV, 10 MW, in which all the components are fabricated by the solid-state elements, (3) highspeed open-type cryocondensation pump for the vacuum system. Test results of each component are compared with the design value of them. Overall test including the beam extraction of up to 120 keV, — 20 A for 1 sec is satisfactorily completed by applying 1/4 size model ion source.

21994 (ITEF—122(1985)) **Numerical investigation of resistive longitudinal instability of nonbunched beam in heavy-ion rings.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87700977.

Using quasilinear theory numerical investigation of nonlinear stage of development of resistive longitudinal instability of nonbunched charged particle beam in heavy-ion rings for inertial synthesis is carried out. Using quasilinear theory for the system of the Vlasov equations this instability may be suppresed by forming a beam with a special form of particle momentum distribution function having a so called "tails". Calculations carried out for one-mode regime showed that particle diffusion from stationary distribution region to the resonance of the beam coherent oscillations result in appearance of self-stabilized distribution function "tail". Dependence of particle number in the "tail" on longitudinal coupling impedance and other beam parameters is estimated. It is shown that in the frame of quasilinear theory self-stabilization mechanism is effective only in case when the beam is not far from instability region boundary calculated according to linear theory. 9 refs.; 3 figs.

21995 (JAERI-M—85-176) **Summary of conceptual design study of fusion experimental reactor (FER). FY 1984 report.** (Japan Atomic Energy Research Inst., Tokyo). Nov 1985. 92p. (In Japanese). NTIS (US Sales Only), PC A05/MF A01. File Number DE87701004.

Since 1980 the design study has been conducted at JAERI for the Fusion Experimental Reactor (FER) which has been proposed to be the next machine to JT-60 in the Japanese long term program of fusion reactor development. Starting from 1984 FER design is now being reviewed and redesigned. This report is the summary of the report which describes the results obtained in the review and redesign activities in 1984. The following three steps are followed in those activities; critical issues study step in which FER critical issues were reviewed and the frame of FER design was revised, torus structure selection step in which a few options within the frame for FER were examined and design step in which major components of the torus structure were designed. The newly established frame for FER design is as follows: 1) Plasma: Self-ignition, 2) Operation scenario: Quasi-steady state operation with long burn pulse, 3) Neutron fluence on the first wall: 0.3 MWY/m/sup 2/, 4) Blanket: Non-tritium breeding blanket with test modules for breeding blanket development, 5) Magnets: Superconducting Magnets.

21996 **(JAERI-M—85-179) Parametric and alternative studies for fusion experimental reactor (FER) (FY 1984).** (Japan Atomic Energy Research Inst., Tokyo). Jan 1986. 466p. (In Japanese). NTIS (US Sales Only), PC A20/MF A01. File Number DE87701005.

Since 1980 the design study has been conducted at JAERI for the Fusion Experimental Reactor (FER) which has been proposed to be the next machine to JT-60 in the Japanese long term program of fusion reactor development. Starting from 1984 FER design is being reviewed and redesigned. This report is a part of the interim report which describes the results obtained in the review and redesign activities in FY 1984. This report includes the following parametric and alternative studies for the FER reference design: 1) parametric studies concerning with core plasma magnets, and operation scenario and power supply, 2) tritium breeding blanket, 3) the study for the steady state operation FER, 4) OTHERS.

21997 **(JAERI-M—85-189) Verification experiment of 15T-split coil(Splitar-15).** (Japan Atomic Energy Research Inst., Tokyo). Nov 1985. 14p. (In Japanese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701006.

In order to test the 12 T-10 kA superconducting cables, which were developed for the high field toloidal coils, the split backup field coil is under construction. This split coil generate very high field of 15 T with backup field, and is operated with large winding current density of 70 A/mm/sup 2/ due to the geometrical limit. This split coil is named 'Splitar-15'. The following results are obtained through the R and D works for the Splitar-15. (1) To generate the maximum field of 15.25 T with the average winding current density of 140 A/mm/sup 2/ is verified by the charging test of the R and D coil. (2) By the optimization of the heat treatment condition, the high stabilized conductor, which has small residual resistance and large critical current density, is developed. (3) By the reduction of the superconducting filament diameter, the high magnetically stable conductor, in which flux jump is not almost occurred, is developed.

21998 **(JAERI-M—85-204) Thermal cycle testing of TiC-coated molybdenum by infrared heating.** (Japan Atomic Energy Research Inst., Tokyo). Dec 1985. 10p. (In Japanese). NTIS (US Sales Only), PC A02/MF A01. File Number DE87701007.

TiC films which were composed of various C/Ti ratios were formed on molybdenum substrates by the reactive evaporation method, and the adhesion of the films were investigated by a cyclic infrared heating. The result shows that stoichiometric TiC films have the best adhesive characteristics for molybdenum. The reactive evaporation method will be applied to the in-situ coating for JT-60.

21999 **(JAERI-M—85-205) Annual report of the Fusion Research Center for the period of April 1, 1984 to March 31, 1985.** (Japan Atomic Energy Research Inst., Tokyo). Jan 1986. 231p. NTIS (US Sales Only), PC A11/MF A01. File Number DE87701008.

Research and development activities of the Fusion Research Center (Department of Large Tokamak Development and Department of Thermonuclear Fusion Research) from April 1984 to March 1985 are described. The JT-60 program progressed as scheduled. Commissioning of the JT-60 tokamak was completed by the end of the period under review. In parallel with installation and test of the tokamak machine, installation of basic diagnostic instruments and examination of the procedure for experiment had been made to meet the first phase Joule heating experiment. (The first plasma discharge was recorded on April 8, 1985). Construction of auxiliary heating systems had continued. A medium-sized tokamak, JFT-2M, had been operated for high-power ICRF heating and ECH assisted LH current drive experiments. Installation of a power supply for plasma shaping in JFT-2M was completed. In the field of plasma theory, detailed analysis had been made on nonlinear kink/tearing modes in a plasma with free boundary and also on ICRF heating. Development of a high-voltage, high-current He ion source for JT-60 plasma diagnostics had proceeded successfully, and tests of JT-60 LH and ICRF luanchers as well. Surface erosion of a new ceramics, SiC with BeO addition by proton bombardment was studied. In IEA's Large Coil Task, three coil test was made at ORNL. A 11 T experiment of TMC-1, a large-bore Nb/sub 3/Sn coil was completed. Commissioning tests of tritium handling facilities had proceeded in the Tritium Process Laboratory. Design studies of the Fusion Experimental Reactor (FER) and INTOR had been advanced.

22000 **(JAERI-M—85-215) Development of the piezoelectric gas injection valve for JT-60.** (Japan Atomic Energy Research Inst., Tokyo). Jan 1986. 87p. (In Japanese). NTIS (US Sales Only), PC A05/MF A01. File Number DE87701011.

Piezoelectric gas injection valve (PEV) for JT-60 have been developed which was a piezo-electric element. The raliability of the PEV under the actual condition of high magnetic fields and high temperatures are veryfied, and it became clear that the PEV had enough throughput range and sufficient repetability for long life throughput characteristics. Remarkables of the developed PEV are summarized as follows, (1) The maximum throughput rate, responce time and helium leakage rate satisfy the desiged specifications. (2) Throughput equation for PEV is clarified by comparison with experiment. (3) Reliabilities of PEV under the actual condition during coil power test become clear.

22001 **(JAERI-M—86-006) MHD equilibrium analysis method of JT-60 based on magnetic measurements.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1986. 52p. (In Japanese). NTIS (US Sales Only), PC A04/MF A01. File Number DE87701019.

A code has been developed to calculate MHD equilibrium configuration in JT-60 from magnetic pick-up signals, plasma current, and external coil currents. To investigate equilibrium configuration, we must seek out a solution of Grad-Shafranov equation which reproduces experimental magnetic data. Fast boundary identification using discrete filaments at prespecified locations proved to be effective in the JT-60 divertor configuration. When we solve the MHD equilibrium as a fixed boundary problem incorporating results of the fast boundary identification, iterative calculations converge rapidly. We derived an efficient method of modifying unknown parameters which specify plasma current profile to obtain nonlinear least-squares solutions. Poloidal $\beta$ value and internal inductance can be separated in the JT-60 configuration with nearly circular cross-section. The estimation error of $\beta$/sub p/ is less than +- 0.05 when input magnetic data contains 1% error.

22002 **(JAERI-M—86-008) Numerical studies on JT-60 divertor plasma characteristics.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1986. 58p. (In Japanese). NTIS (US Sales Only), PC A04/MF A01. File Number DE87701021.

The characteristics of divertor plasma in JT-60 were numerically studied both for Joule heated plasma and for high power heated one. The effects of parameters related to divertor plasma or main plasma on these characteristics were analyzed. The former parameters include divertor chamber shape, divertor configuration, width of scrape-off layer, effective pumping speed, radiation loss and so on. The latter parameters include main plasma density, input power, particle diffusion coefficient and safety factor. The dominant parameters on divertor plasma characteristics and the conditions required to produce cold and dense divertor plasma were clarified. In order to investigate the above subject, a new simulation model was developed by which both divertor plasma and main plasma can be consistently analyzed.

22003 **(Juel—2060) Measurement of the space dependent tritium production rates and energy depositions in a fusion reactor blanket model by thermoluminescence detectors (TLD).** Goergen, G. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Technische Hochschule Aachen (Germany, F.R.)). Apr 1986. 164p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87751266.

The space dependent energy deposition and tritium production rate for a lithium-metal fusion reactor blanket model is determined using the computer programs MORSE-CG and MACK-IV. The glowcurves of LiF TLD which are irradiated in the blanket by

14.1 MeV source neutrons are divided in several Gauss-peaks by computer. The measured peak areas can be compared to the calculated space dependent energy depositions for the different reactions in the TLD. A new method has been developed to measure the space dependent tritium production rate generated by the different Li-isotopes in the blanket using TLD. The glowcurves of the TLD are analysed and compared after irradiation with neutrons, $\alpha$-particles and deuterons of different energies.

22004 **(KFK—4105) Study on tritium separation from LiPb by permeation into Na or NaK and cold trapping.** Reimann, J.; Malang, S. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente). Oct 1986. 87p. NTIS (US Sales Only), PC A05/MF A01. File Number DE87751267.

The tritium separation and recovery method discussed in this report appears to be a very promising technique for a LiPb self cooled blanket where an intermediate loop is required for safety reasons anyway. This technique can be also of interest for a water cooled LiPb blanket if a tritium purification unit exists in the water loop. Considerable work has been done on cold trapping of hydrogen from Na flows for the fast breeder technology. More work is needed in respect to fusion blanket applications, especially, on hydrogen removal from cold traps by thermal hydride decomposition. This report summarizes the state of the art on the precipitation and decomposition processes and discusses practical experiences with cold traps. Some ideas on a fusion blanket cold trap are outlined and a research program covering the more fundamental aspects for the next future is proposed.

22005 **(KFK—4142) Simple method to calculate neutron energy deposition in ICF targets.** Goel, B.; Henderson, D. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Oct 1986. 18p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751276.

In most ICF-target simulation calculations $\alpha$'s and other charged particles are supposed to be reabsorbed in the plasma whereas neutrons are often allowed to escape without interaction. However, in reactor size targets neutrons lose about the same amount of energy in the DT-fuel as $\alpha$-particles and can considerably influence the burn characteristics of the target. In the present paper a simple method to account for neutron-fuel interaction is presented. Results are compared with Monte-Carlo and S/sub N/ transport calculations. The effect of neutron energy deposition in the fuel on the performance is shown on the 4 mg DT-target of the HIBALL reactor.

22006 **(KMSF-U—1821) A novel $^3$He scintillation detector.** Knoll, G.F.; Henderson, T.M.; Felmlee, W.J. (Michigan Univ., Ann Arbor (USA); KMS Fusion, Inc., Ann Arbor, MI (USA)). 1986. Contract AC08-82DP40152. 7p. (CONF-861007—25). NTIS, PC A02. File Number DE87003424.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

A $^3$He scintillation detector of unique design has been fabricated and tested. It incorporates high-pressure helium gas contained within small spherical glass shells dispersed in a plastic scintillator matrix. The detector displays a unique combination of properties including high detection efficiency, fast response, and convenient physical form.

22007 **(KMSF-U—1824) Classical and holographic interferometry systems combined to document inertial fusion experiments.** Ankney, J.S.; Busch, G.E. (KMS Fusion, Inc., Ann Arbor, MI (USA)). 1986. Contract AC08-82DP40152. 4p. (CONF-861038—7). NTIS MF A01; 2; GPO Dep. File Number DE87003425.

From OSA/APS international laser science conference; Seattle, WA, USA (20 Oct 1986).

An optical system has been developed which is used to document inertial fusion experiments. It records both classical interferograms of solid hydrogen isotope layers within the hollow spherical fuel container prior to the shot and holographic interferograms of the plasma during the implosion. This optical system has the advantages of visible and uv utility, 2 to 4 $\mu$m resolution and a low space requirement. Both systems share a catadioptric objective lens and a refractive relay lens. The visible classical interferometric beam and the uv pulsed holographic probe follow different off-axis paths within the object cone of the lenses. To document the solid layer, the beam is diverted to a shearing cube interferometer using a lens-mirror assembly on a sliding stage. This assembly then slides out of the way before the implosion to admit the uv probe to the holographic camera, which records four holographic interferograms of the plasma separated in time by 40 to 400 ps. The two operational modes, shearing interferometer and holographic, are serial; switching from one to the other requires only seconds.

22008 **(LA-UR—86-3556) Tritium fuel cycle technology at the Tritium Systems Test Assembly.** Anderson, J.L.; Bartlit, J.R. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 5p. (CONF-8610214—1). NTIS, PC A02. File Number DE87001964.

From International symposium on fusion reactor blanket and fuel cycle technology; Tokai-mura, Japan (27 Oct 1986).

The Tritium Systems Test Assembly (TSTA) at Los Alamos is charged with developing the tritium technology required to fuel a fusion reactor. A second major task is the development and evaluation of personnel and environmental protection systems associated with the tritium handling facilities at a fusion reactor. Tritium experiments were initiated in June 1984 when 10 g of tritium was introduced into the cryogenic distillation isotope separation system. In September 1986 the tritium inventory was increased to 50 g, the fuel cleanup system was used to remove impurities from the gas and extremely pure (>99.9%) tritium was prepared in the isotope separation system. The success of the TSTA operation is demonstrated by the fact that from June 1984 through September 1986 more than 5 x $10^8$ Ci of tritium have been processed at TSTA. During this period less than 15 Ci of tritium have been released to the environment. Personnel exposures during this time have totaled less than 100 person-mRem. Experiments performed during this period include the tests on the isotope separation and fuel cleanup system; tests to study the contamination and decontamination of surfaces exposed to elemental tritium and tritium oxide; evaluation of a commercial getter for glovebox atmosphere detritiation tritium testing on a palladium alloy membrane diffuser; and evaluation of a ceramic electrolysis cell for decomposing tritiated water. The latter two experiments are being done in cooperation with the Japan Atomic Energy Research Institute.

22009 **(PPPL—2394) Measurements of fusion product emission profiles in tokamaks.** Strachan, J.D.; Heidbrink, W.W.; Hendel, H.W.; Lovberg, J.; Murphy, T.J.; Nieschmidt, E.B.; Tait, G.D.; Zweben, S.J. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Nov 1986. Contract AC02-76CH03073. 34p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87005628.

The techniques and results of fusion product emission profile measurements are reviewed. While neutron source strength profile measurements have been attempted by several methods, neutron scattering is a limitation to the results. Profile measurements using charged fusion products have recently provided an alternative since collimation is much easier for the charged particles.

22010 **(SAND—87-0191C) PBFA II [Particle Beam Fusion Accelerator 2] APEX pulse shaping project.** Crow, J.T. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 7p. (CONF-861256—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005531.

From Topical conference on the physics of radiatively driven ICF targets; Albuquerque, NM, USA (8 Dec 1986).

The APEX Project will develop a system of ion beam pulse-shaping and target standoff for installation on PBFA II. The project will include development of an efficient ion diode and plasma transport channels for ion beam propagation over several meters. The ion beam will have a pulse shape, power and area appropriate for achieving gain from a D-T fusion target. The system, as presently conceived, will use a single diode, single transport channel, and a target designed for single-sided illumination. The basic APEX system is described.

22011 **(UCID—20773-Vol.1) MINIMARS conceptual design: Final report.** Lee, J.D. (ed.). (Lawrence Livermore National Lab., CA (USA); Oak Ridge National Lab., TN (USA); Wisconsin Univ., Madison (USA); General Dynamics Corp., San Diego, CA (USA). Space Systems Div.; Grumman Aerospace Corp., Bethpage, NY (USA); Canadian Fusion Fuels Technology Project, Toronto, Ontario). Sep 1986. Contract W-7405-ENG-48. 532p. NTIS, PC A23/MF A01; 1; GPO Dep. File Number DE87006584.

This volume of the conceptual design report contains detailed information on the following: (1) plasma engineering, (2) tandem mirror optimization code, (3) configuration, (4) assembly and maintenance, (5) availability, (6) site and facilities, (7) magnet design, (8) end-cell shielding, (9) drift pumping system, (10) rf systems, (11) negative-ion neutral beam injection system, (12) sloshing-ion beamline, and (13) power balance and electrical systems. (MOW)

22012 **(UCID—20994) MacFuse: A laser fusion simulation code for the Macintosh.** Harrison, A.K. (Lawrence Livermore National Lab., CA (USA)). Feb 1987. Contract W-7405-ENG-48. 43p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006599.

This paper describes an inertial-confinement-fusion (ICF) simulation code and associated postprocessor written and run on a Macintosh Plus microcomputer. The objectives of this work were the following: to give the author experience in ICF target design; to familiarize him with physics, numerical methods and code structure typical of a target design code; and to explore the extent to which target design could be carried out with limited computing resources. 8 refs., 48 figs.

22013 **(UCRL—15871) Design and operation of 140 GHz gyrotron oscillators for power levels up to 1 MW CW.** Jory, H.; Bier, R.; Craig, L.J.; Felch, K.; Ives, L.; Lopez, N.; Spang, S. (Varian Associates, Inc., Palo Alto, CA (USA); Lawrence Livermore National Lab., CA (USA)). Dec 1986. Contract W-7405-ENG-48. 7p. NTIS, PC A02. File Number DE87006683.

Varian has designed and tested 140 GHz gyrotron oscillators that have generated output powers of 100 kW CW and 200 kW for 1 ms pulses. Upcoming tubes will be designed to operate at power levels of 200 kW CW and ultimately up to 1 MW CW. The important design considerations which are addressed in the higher power tubes include the design of the electron gun, interaction circuit, and output window. These issues will be discussed and the results of the earlier 140 GHz gyrotron work at Varian will be summarized.

22014 **(UCRL—94044) Radiation associated with an inertial confinement fusion laser system.** Singh, M.S. (Lawrence Livermore National Lab., CA (USA)). 3 Dec 1986. Contract W-7405-ENG-48. 12p. (CONF-870219—10). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003814.

From Midyear topical symposium of the Health Physics Society: health physics of radiation-producing machines; Reno, NV, USA (8 Feb 1987).

The primary objective the LLNL Laser Fusion Program is to understand and develop the science and technology of inertial confinement fusion. Nova, a 100-TW/100-kJ laser system, has demonstrated efficient compression, ignition, and burn of D-T fusion fuel. The LLNL fusion computer program (LASNEX) and experiments strongly support achieving high gain with the proposed multi-MJ laser system. In this paper, I examine the prompt and residual radiations associated with these laser systems. 3 refs., 6 figs., 4 tabs.

22015 **(UCRL—95759) High current density magnets for INTOR and TIBER.** Miller, J.R.; Henning, C.D.; Kerns, J.A.; Slack, D.S.; Summers, L.T.; Zbasnik, J.P. (Lawrence Livermore National Lab., CA (USA)). Dec 1986. Contract W-7405-ENG-48. 37p. (CONF-861253—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87003819.

From International tokamak reactor workshop; Vienna, Austria (1 Dec 1986).

The adoption of high current density, high field, superconducting magnets for INTOR and TIBER would prove beneficial. When combined with improved radiation tolerance of the magnets to minimize the inner leg shielding, a substantial reduction in machine dimensions and capital costs can be achieved. Fortunately, cable-in-conduit conductors (CICC) which are capable of the desired enhancements are being developed. Because conductor stability in a CICC depends more on the trapped helium enthalpy, rather than the copper resistivity, higher current densities of the order of 40 A/mm$^2$ at 12 T are possible. Radiation damage to the copper stabilizer is less important because the growth in resistance is a second-order effect on stability. Such CICC conductors lend themselves naturally to niobium-tin utilization, with the benefits of the high current-sharing temperature of this material being taken to advantage in absorbing radiation heating. When the helium coolant is injected at near the critical pressure, Joule-Thompson expansion in the flow path tends to stabilize the fluid temperature at under 6 K. Thus, higher fields, as well as higher current densities, can be considered for INTOR or TIBER.

22016 **Operation of a Dudnikov type Penning source with $LaB_6$ cathodes.** Leung, K.N.; DeVries, G.J.; Ehlers, K.W.; Jackson, L.T.; Stearns, J.W.; Williams, M.D.; McHarg, M.G.; Ball, D.P.; Lewis, W.T.; Allison, P.W.; and others. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Review of Scientific Instruments;* **58**: No. 2, 235-239(Feb 1987). Contract AC03-76SF00098.

The Dudnikov type Penning source has been operated successfully with low work function $LaB_6$ cathodes in a cesium-free discharge. It is found that the extracted $H^-$ current density is comparable to that of the cesium-mode operation and $H^-$ current density of 350 mA/cm$^2$ have been obtained for an arc current of 55 A. Discharge current as high as 100 A has also been achieved for short pulse durations. The $H^-$ yield is closely related to the source geometry and the applied magnetic field. Experimental results demonstrate that the majority of the $H^-$ ions extracted are formed by volume processes in this type of source operation.

22017 **Recyclotron III, a recirculating plasma fusion system.** Jarnagin, W.S. US Patent 4,639,348. 27 Jan 1987. Filed date 13 Nov 1984. vp.

This patent describes a recyclotron nuclear fusion system comprising recyclotrons. Each recyclotron comprises cyclotron means for receiving and accelerating charged particles in spiral and work conservative pathways. An output means forms a beam from particles received from the cyclotron means; (i) the cyclotron means comprising (a) a channel shaped electromagnet having a pair of indented polefaces, oriented along an input axis and defining an input axis and defining an input magnetic well, (b) a pair of elongated linear electrodes centered along the input magnetic well arranged generally parallel to the input axis and having a gap therebetween, (c) tuned oscillator means connected to the electrodes for applying an oscillating electric potential thereto, (ii) the output means comprising (e) inverter means comprising an electromagnet having a polarity opposite that of the channel shaped electromagnet oriented contigously therealong for extracting fully accelerated particles from the cyclotron means, and (f) reinverter means comprising an electromagnet having a polarity the same as that of the channel shaped electromagnet for correcting the flightpath of the extracted particles.

22018 **Production of /sup 91/Nb, /sup 94/Nb, and /sup 95/Nb from Mo by 14.5—14.8 MeV neutrons.** Greenwood, L.R.; Doran, D.G.; Heinisch, H.L. (Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review* [*Section*] *C: Nuclear Physics;* **35**: No. 1, 76-80(Jan 1987). Contract W-31-109-ENG-38.

Production cross sections for /sup 94/Nb(2.03 x 10$^4$ yr) have been measured from enriched /sup 94/Mo and /sup nat/Mo. The samples were irradiated by 14.5—14.8 MeV neutrons and the cross sections were measured by gamma spectroscopy. The cross section for the /sup 95/Mo(n,np+d)/sup 94/Nb reaction was deduced from the difference in /sup 94/Nb activity in the natural and enriched Mo samples. Cross sections were also determined for the /sup 95/Mo(n,p)/sup 95/Nb, /sup 92/Mo(n,x)/sup 91/Nb/sup m/, and /sup 98/Mo(n,$\alpha$)/sup 95/Zr reactions, all being in good agreement with previous data. Our data can also be used to estimate the

production of the long-lived (700 yr) ground state of /sup 91/Nb/ sup g/ from /sup 92/Mo.

22019 **(UCRL-Trans—12153) Conceptual design of negative-ion-based 500 keV, 20 MW neutral beam injector.** Horiike, Hiroshi; Ohara, Yoshihiro; Okumura, Yoshikazu; Shibata, Takemasa; Tanaka, Shigeru. (Lawrence Livermore National Lab., CA (USA); Japan Atomic Energy Research Inst., Tokyo). Jan 1987. Contract W-7405-ENG-48. Translation of JAERI-M86-04, April 1986. 195p. NTIS, PC A09/ MF A01; 1; GPO Dep. File Number DE87005504.

The conceptual design of the source plasma generator and the accelerating system is presented. Three candidate systems are then examined, each with a different neutralizing cell. The system having a very long neutralizer was judged to be the most suitable to the reactor considered. It was designed in detail. The long neutralizer (30 m) has many advantages: (1) the ion source can be located far from the reactor, permitting a narrow injection tube and tangential injection angle; (2) neutron shielding is easy because the solid angle of the beam line is very small; (3) complex components are removed from the vicinity of the reactor.

22020 **Effect of capsule aspect ratio on hydrodynamic efficiency.** Pollaine, S.M.; Lindl, J.D. (Lawrence Livermore National Lab., CA). *Nuclear Fusion;* **26**: No. 12, 1719-1723(Dec 1986).

Using LASNEX, the authors investigate the effect of initial fuel aspect ratio on the hydrodynamic efficiency and implosion stability of 1 mg ICF capsules directly driven with 0.27 μm light. It is concluded that these capsules will be either hydrodynamically inefficient, with less than 8% of the incident laser energy converted into fuel kinetic energy, or hydrodynamically unstable, with an in-flight aspect ratio greater than 80, unless the instability growth rate can be reduced to a small fraction of its classical value. 4 references, 10 figures.

22021 **Heavy ion fusion. Report on the international symposium, held at Washington, DC, USA, 27-29 May 1986.** Bangerter, R.O.; Keefe, D. (Lawrence Livermore National Lab., CA). *Nuclear Fusion;* **26**: No. 12, 1741-1747(Dec 1986).

This report on the International Symposium on Heavy Ion Fusion held May 27-29, 1986 summarizes the problems and achievements in the areas of targets, accelerators, focussing, reactor studies, and system studies. The symposium participants recognize that there are large uncertainties in Heavy Ion Fusion but many of them are also optimistic that HIF may ultimately be the best approach to fusion. 1 table.

22022 **A folded waveguide coupler for plasma heating in the ion cyclotron range of frequencies.** Owens, T.L. (Mc Donnell Douglas Astronautics Co., St. Louis, MO 63166). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 6, 934-946(Dec 1986).

A new type of waveguide coupler for plasma heating experiments in the ion cyclotron range of frequencies (ICRF) is introduced. The coupler consists of a series of interleaved metallic vanes within a rectangular enclosure analogous to a very wide simple rectangular waveguide that has been "folded" several times. At the mouth of the coupler a plate is attached which contains coupling apertures in each "fold" or every other "fold" depending upon the application. This plate serves primarily as a wave field polarizer that converts coupler fields to the polarization of the fast magnetosonic wave within a plasma. Theoretical estimates indicate that the folded waveguide coupler is capable of high-efficiency multimegawatt operation into a plasma.

22023 **Advantages of high-field tokamak for fusion reactor development.** Cohn, D.R.; Bromberg. L. (MIT Plasma Fusion Center, Cambridge, MA). *Journal of Fusion Energy;* **5**: No. 3, 161-170(Sep 1986).

High-field designs could reduce the cost and complexity of tokamak reactors. Moreover, the certainty of achieving required plasma performance could be increased. Strong Ohmic heating could eliminate or significantly decrease auxiliary heating power requirements and high values of n/tau/ /SUB e/ could be obtained in modest-size plasmas. Other potential advantages are reactor operation at modest values of B, capability of higher power density and wall loading, and possibility of operation with advanced fuel mixtures. Present experimental results and basic scaling relations imply that the parameter $B^2a$, where B is the magnetic field and a is the minor radius, may be of special importance. A superhigh-field compact ignition experiment with very high values of $B^2a$ (e.g., $B^2a=150$ $T^2$ m) has the potential of Ohmically heating to ignition. This short-pulse device would use inertially cooled copper plate magnets. Compact engineering test reactor and/or experimental hybrid reactor designs would use steady-state, water-cooled copper magnets and provide long-pulse operation. Design concepts are also described for demonstration / commercial reactors. These devices could use high-field superconducting magnets with 7-10 T at the plasma axis.

22024 **Fast-fission tokamak breeder reactors.** Jasshy, D.L.; Berwald, D.H.; Garner, J.; Lee, J.D.; Maya, I.; Moir, R.W.; Whitley, R.H.; Wong, C.P.C. (Princeton Plasma Physics Laboratory, Princton, NJ). *Journal of Fusion Energy;* **5**: No. 3, 171-180(Sep 1986).

A fast-fission blanket around a fusion plasma exploits high neutron multiplication for superior breeding and high-energy multiplication to generate significant net electrical power. A major improvement over previous fast-fission blanket concepts is the use of mobile fuel, namely a pebble-bed configuration with helium cooling. Upon loss of coolant, the mobile fuel can be gravity-dumped to a separately cooled dump tank before excessive temperatures are reached. The pebble bed is also compatible with rapid fuel exchange and a low-cost reprocessing method. With the ignited tokamak plasma producing 620 MW of fusion power, the net electric power is 1600 MW /SUB e/ and the annual fissile production exceeds 3 tonnes.

22025 **The need and prospects for improved fusion reactors.** Krakowski, R.A.; Hagenson, R.L.; Miller, R.L. (Los Alamos National Laboratory, Los Alamos, NM). *Journal of Fusion Energy;* **5**: No. 3, 213-230(Sep 1986).

Conceptual fusion reactor studies over the past 10-15 yr have projected systems that may be too large, complex, and costly to be of commercial interest. One main direction for improved fusion reactors points toward smaller, higher-power-density approaches. First-order economic issues (i.e., unit direct cost and cost of electricity) are used to support the need for more compact fusion reactors. The results of a number of recent conceptual designs of reversed-field pinch, spheromak, and tokamak fusion reactors are summarized as examples of more compact approaches. While a focus has been placed on increasing the fusion-power-core mass power density beyond the minimum economic threshold of 100-200 kWe/tonne, other means by which the overall attractiveness of fusion as a long-term energy source are also addressed.

22026 **Fueling of naval and space reactors with U-233 produced in a fusion reactor blanket.** Jassby, D.L. (Princeton Plasma Physics Laboratory, Princeton, NJ). *Journal of Fusion Energy;* **5**: No. 3, 245-246(Sep 1986).

This note estimates the minimum annual demand for fissile fuel of a system of naval reactors and the required capacity of a fusion neutron source that could supply the fuel by breeding in a thorium-containing blanket.

22027 **Lithium nitrate as a fusion reactor coolout fluid? A thermochemical assessment.** Adamson, M.G.; Calef, D.; Moir, R.W. (Lawrence Livermore National Laboratory, Livermore, CA). *Journal of Fusion Energy;* **5**: No. 3, 247-252(Sep 1986).

In connection with possible application as a coolant fluid in fusion reactors, molten $LiNO_3$ and $LiNO_3/LiNO_2$ mixtures, and their mixtures with Na/K nitrates, have been evaluated with respect to their high temperature stability, their ability to reversibly dissolve and release tritium and, in a very limited sense, their corrosiveness toward structural alloys. The results of the primarily thermochemical evaluation indicate that with respect to thermal/radiolytic decomposition and corrosivity $LiNO_3/LiNO_2$ may be suitable

for application up to about 700 degrees K; however, with respect to reversibility/irreversibility of tritium release, it appears unsuitable a all likely operating temperatures ( about 675-800 degrees K).

22028 **Some thoughts on the production of muons for fusion catalysis.** Chapline, G.; Moir, R. (Lawrence Livermore National Laboratory, Livermore, CA). *Journal of Fusion Energy;* **5**: No. 3, 191-200(Sep 1986).

For muon-catalyzed fusion to be of practical interest, a very efficient means of producing muons must be found. We describe here some schemes for producing muons that may be more energy efficient than any heretofore proposed. There are, in particular, some potential advantages of creating muons from collisions of high-energy tritons confined in a magnetic mirror configuration. If one could catalyze 200 fusions per muon and employ a uranium blanket that would multiply the neutron energy by a factor of ten, one might produce electricity with an overall plant efficiency (ratio of electric energy produced to nuclear energy released) approaching 30%.

22029 **Fusion-neutron production in the TFTR with deuterium neutral-beam injection.** Hendel, H.W.; England, A.C.; Josshy, D.L.; Mirin, A.A.; Nieschmidt, E.B. (RCA David Sarnoff Research Center, Princeton, NJ). *Journal of Fusion Energy;* **5**: No. 3, 231-244(Sep 1986).

We report measurements of the fusion reaction rate in the Tokamak Fusion Test Reactor (TFTR) covering a wide range of plasma conditions and injected neutral-beam powers up to 6.3 MW. The fusion neutron production rate in beam-injected plasmas decreases slightly with increasing plasma density n /SUB e/ , even though the energy confinement parameter n /SUB e/ t /SUB e/ generally increases with density. The measurements indicate and Fokker-Planck simulations show that with increasing density the source of fusion neutrons evolves from mainly beam-beam and beam-target reactions at very low n /SUB e/ to a combination of beam-target and thermonuclear reactions at high n /SUB e/ . At a given plasma current, the reduction in neutron source strength at higher n /SUB e/ is due to both a decrease in electron temperature and in beam-beam reaction rate. The Fokker-Planck simulations also show that at low n /SUB e/ , plasma rotation can appreciably reduce the beam-target reaction rate for experiments with coinjection only. The variation of neutron source strength with plasma and beam parameters is as expected for beam-dominated regimes. However, the Fokker-Planck simulations systematically overestimates the measured source strength by a factor of 2-3; the source of this discrepancy has not yet been identified.

22030 **Lithium plasma generation for PBFA-II ion diodes.** Rice, J.K.; Gerber, R.A.; Tisone, G.C. (Sandia National Laboratories, Albuquerque, NM). *AIP (American Institute of Physics) Conference Proceedings;* **146**: No. 1, 654-657(15 Aug 1986). (CONF-851185—). Contract AC04-76DP00789.

From International laser science conference; Dallas, TX, USA (18 Nov 1985).

The selection of lithium as the ion for PBFA II has made the development of a suitable lithium ion source one of the highest priority areas in the light-ion fusion program. Several schemes for producing lithium ions in a suitable diode configuration are being actively pursued. One attractive option is to use the LIBORS laser ionization technique on a thin layer of lithium vapor near the anode. A space- and time-dependent model of this process has been developed to guide system design studies, and experiments are being performed to validate model predictions.

22031 **Inertial confinement fusion with light ion beams.** VanDevender, J.P.; Cook, D.L. (Sandia National Labs., Albuquerque, NM). *Science (Washington, D.C.);* **232**: 831-836(16 May 1986). Contract AC04-76DP00789.

The Particle Beam Fusion Accelerator II (PBFA II) is presently under construction and is the only existing facility with the potential of igniting thermonuclear fuel in the laboratory. The accelerator will generate up to 5 megamperes of lithium ions at 30 million electron volts and will focus them onto an inertial confinement fusion (ICF) target after beam production and focusing have been optimized. Since its inception, the light ion approach to ICF has been considered the one that combines low cost, high risk, and high payoff. The beams are of such high density that their self-generated electric and magnetic fields were thought to prohibit high focal intensities. Recent advances in beam production and focusing demonstrate that these self-forces can be controlled to the degree required for ignition, break-even, and high gain experiments. ICF has been pursued primarily for its potential military applications. However, the high efficiency and cost-effectiveness of the light ion approach enhance its potential for commercial energy application as well.

22032 **Heavy ion inertial fusion.** Reiser, M.; Godlove, T.; Bangerter, R. (eds.). New York, NY; American Institute of Physics (1986). 634p. (CONF-860510—). American Institute of Physics, 335 E. 45th St., New York, NY 10017. File Number TI87005365.

From Symposium on heavy ion inertial fusion; Washington, DC, USA (27 May 1986).

Separate abstracts for each included paper have been entered into the data base. (MOW)

22033 **Search for lower hybrid drift fluctuations in a field-reversed configuration by means of carbon dioxide heterodyne scattering.** Carlson, A.W. Seattle, WA; Univ. of Washington (1986). 143p. University Microfilms Order No. 86-26,633.

Thesis (Ph. D.).

A measurement reported sets an upper bound on LHD like density fluctuations in an FRC, which is two orders of magnitude below the predicted levels. Particle loss from FRC's is known to occur anomalously fast, and this is usually attributed to effects of the LHD instability. If LHD waves are present, they can be measured using heterodyne detection of $CO_2$ laser light scattered from the associated density fluctuations. In this study the usual scattering system was successfully modified to compensate for severe refraction of the beams by the plasma. This system was calibrated by detection of an electrooptically modulated $CO_2$ laser beam, and by detection of light scattered from acoustic waves in salt. The plasma measurements made on the TRX-2 field reversed theta pinch covered all parameters at which LHD fluctuations might be expected to occur, namely wavenumbers from 30 to 240 $cm^{-1}$, frequencies from 10 to 300 MHz, and radii from one centimeter inside the separatrix to two centimeters outside. The lack of detectable scattered light under any of these conditions indicates $(\delta n/n) < 1 \times 10^{-4}$, compared to predictions of $(\delta n/n) \sim 1 \times 10^{-2}$ based on mode coupling theory, ion-trapping theory, and observed transport rates. Several mechanisms are discussed that may stabilize LHD in these plasmas. Several alternate explanations of the observed anomalous transport rates in FRC's are also discussed.

22034 **Summary abstract: fabrication of Rayleigh-Taylor instability experiment.** Hsieh, E.J.; Hatcher, C.W.; Miller, D.E. (Lawrence Livermore Lab., CA). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **3**: No. 3, 1278-1279(May-Jun 1985). Contract W-7405-ENG-48.

Because of the concern for growth of Rayleigh-Taylor (RT) instabilities, surfaces of targets for implosion experiments must be exceptionally smooth. The 100 A surface smoothness requirement could be conservative, expensive insurance against RT instabilities. Will instabilities grow at 500 or 1000 A surface smoothness? What are the approaches to minimize the RT instability effects? The present RT experiments are designed to answer some of these questions. The authors approach to the problem has been to fabricate planar targets with known defects so that their performance can be compared with theoretical predictions. Since it is difficult to make theoretical calculations for a point defect, their RT experiments are designed to test continuous, single-frequency sinusoidal defects of various wavelengths and peak-to-valley heights.

22035 **Laser and plasma technology.** Lee, S.; Tan, B.C.; Wong, C.S.; Chew, A.C. Singapore, Singapore; World Scientific Publishing Co. Pte Ltd. (1985). 690p. (CONF-8312137—). World Scientific Publishing Co. Pte Ltd., 9 Kaki Bukit Rd., 2 Gordon Warehouse 03-01, Singapore, Singapore 1441 SG.

From 1. tropical college on applied physics; Kuala Lumpur, Malaysia (26 Dec 1983).

This book presents the papers given at a conference on laser and plasma technology. Topics considered at the conference included: experiments on plasma focus, glow discharge and the collinear dye laser; basic theory and methods of laser technology; technology of solid state lasers; and basic theory and methods of plasma technology.

22036 **$H^-$ production in a multicusp microwave plasma.** Trow, J.R. Berkeley, CA; Univ. of California (1985). 219p. University Microfilms Order No. 85-25,140.

Thesis (Ph. D.).

High energy neutral beams are necessary for the continued development of magnetically confined fusion plasma devices. Neutral beams based on positive ions are not efficient at beam energies of 100 keV or above; however, negative ion based neutral beam systems are efficient, even at high beam energies. Volume production of $H^-$ has many advantages over the other methods, chiefly: simplicity of design and operation, and no need for alkali metals. Since volume production requires a low electron temperature, but also requires molecular intermediates only formed by more energetic electrons (>20 eV), double plasma devices with a separate hot electron region are desirable. Therefore, an experiment was undertaken to examine $H^-$ production by volume processes in a multicusp microwave discharge, part of the cusp field being enhanced to produce an ECR (electron cyclotron resonance), that would also isolate the hotter plasma formed there. This arrangement is analogous to the magnetic filters used in some other negative ion sources. This work describes the experiment setup and the results obtained, which are a survey of the behavior of this type of device. Also included is a discussion of the volume processes associated with $H^-$ production, including numerical estimates, based on the experimental measurements.

22037 **Physics of plasma-wall interactions in controlled fusion.** Post, D.E.; Behrisch, R. New York, NY; Plenum Press (1984). 1183p. (CONF-8407172—).

From NATO advanced study institute on physics of plasma-wall interactions in controlled fusion; Val-Morin, Quebec, Canada (30 Jul 1984).

In the areas of plasma physics, atomic physics, surface physics, bulk material properties and fusion experiments and theory, the following topics are presented: the plasma sheath; plasma flow in the sheath and presheath of a scrape-off layer; probes for plasma edge diagnostics in magnetic confinement fusion devices; atomic and molecular collisions in the plasma boundary; physical sputtering of solids at ion bombardment; chemical sputtering and radiation enhanced sublimation of carbon; ion backscattering from solid surfaces; implantation, retention and release of hydrogen isotopes; surface erosion by electrical arcs; electron emission from solid surfaces;l properties of materials; plasma transport near material boundaries; plasma models for impurity control experiments; neutral particle transport; particle confinement and control in existing tokamaks; limiters and divertor plates; advanced limiters; divertor tokamak experiments; plasma wall interactions in heated plasmas; plasma-wall interactions in tandem mirror machines; and impurity control systems for reactor experiments.

22038 **Introduction to the physics of plasma wall interactions in controlled fusion.** Post, D.E.; Behrisch, R.; Stansfield, B. (Plasma Physics Laboratory, Princeton University Princeton, NJ). pp 1-14 of Physics of plasma-wall interactions in controlled fusion. Post, D.E.; Behrisch, R. New York, NY; Plenum Press (1984). (CONF-8407172—).

From NATO advanced study institute on physics of plasma-wall interactions in controlled fusion; Val-Morin, Quebec, Canada (30 Jul 1984).

This paper begins by addressing the major physics questions of confinement, beta ratio, heating and current drive, and impurity and particle control necessary to the realization of controlled fusion, and then reviews the current tokamak data base and the operating projections for the current tokamak projects. The paper concludes by classifying the lectures presented at the conference according to subject.

22039 **Properties of materials.** Smith, M.F.; Whitley, J.B. (Sandia National Labs., Albuquerquem, nm). pp 539-605 of Physics of plasma-wall interactions in controlled fusions. Post, D.E.; Behrisch, R. New York, NY; Plenum Press (1984). (CONF-8407172—).

From NATO advanced study institute on physics of plasma-wall interactions in controlled fusion; Val-Morin, Quebec, Canada (30 Jul 1984).

This paper describes the major differences in the basic structures of metals, ceramics, and graphites. The physical properties which strongly influence materials performance in a fusion plasma environment are discussed. The response of materials to severe thermal loads that can be imposed by contract with a plasma are examined. Several figures-of-merit and materials comparisons are presented relating to thermal stress. The effects of radiation on materials are examined.

22040 **Particle confinement and control in existing tokamaks.** Cohen, S.A. (Plasma Physics Lab., Princeton, Univ., NJ). pp 773-853 of Physics of plasma-wall interactions in controlled fusions. Post, D.E.; Behrisch, R. New York, NY; Plenum Press (1984). (CONF-8407172—).

From NATO advanced study institute on physics of plasma-wall interactions in controlled fusion; Val-Morin, Quebec, Canada (30 Jul 1984).

This paper reviews measurements of particle losses relevant to plasmawall interactions in tokamaks. The methods commonly used to measure the confinement and loss of thermal plasma, impurity ions, suprathermal electrons and ions, and photons are compared and evaluated. Refueling and particle control techniques, including pulsed gas and pellet injection and gettering and discharge cleaning, are described.

22041 **Plasma-wall interactions in tandem mirror machines.** Allen, S.L. (Lawrence Livermore National Lab Univ. of California, Livermore, CA). pp 1067-1099 of Physics of plasma-wall interactions in controlled fusion. Post, D.E.; Behrisch, R. New York, NY; Plenum Press (1984). (CONF-8407172—).

From NATO advanced study institute on physics of plasma-wall interactions in controlled fusion; Val-Morin, Quebec, Canada (30 Jul 1984).

This paper describes the plasma-surface interactions in thermalbarrier tandem-mirror machines. The thermal-barrier mode of axial confinement is an integral part of a tandem mirror, and it dictates the required plasma conditions, particularly on the surface of the plasma. A brief description is given of the experimental configuration used in tandem mirrors to create the thermal barrier. The TMX-U and MFTF-B machines are used as specific examples. Relevant plasmasurface interaction issues are addressed, and the experimental results from currently operating tandem mirror machines are included. A summary and discussion of future work concerned with plasma-surface interactions in tandem mirrors are presented.

22042 **Impurity control system for reactor experiments.** Post, D.E.; Matlas, R.F. (Princeton Univ., Princeton, NJ). pp 1101-1147 of Physics of plasma-wall interactions in controlled fusion. Post, D.E.; Behrisch, R. New York, NY; Plenum Press (1984). (CONF-8407172—).

From NATO advanced study institute on physics of plasma-wall interactions in controlled fusion; Val-Morin, Quebec, Canada (30 Jul 1984).

This paper discusses the requirements that an impurity and particle control system must meet. The general plasma physics issues relevant to impurity control and the issues for pumped limiters and poloidal divertors are discussed. The physics of the operation of the "open" divertors described are addressed. Materials issues are summarized and design considerations are described. Examples drawn from the INTOR design studies are used as illustrations. These examples make the relevant points more specific.

22043 **Limiters and divertor plates.** Ulrickson, M. (Princeton Univ, Princeton, NJ). pp 855-890 of Physics of plasma-wall interactions in controlled fusions. Post, D.E.; Behrisch, R. New York, NY; Plenum Press (1984). (CONF-8407172—).

From NATO advanced study institute on physics of plasma-wall interactions in controlled fusion; Val-Morin, Quebec, Canada (30 Jul 1984).

This paper presents the basic physical principles that are important for the design of limiters and divertor plates. The methods used to find a solution within the constraints are described. The author shows how all of the individual effects interact to lead to a design. Some remarks concerning how the designed components are conditioned for optimum performance are presented.

22044 **Advanced limiters.** Mioduszewski, P. (Oak Ridge National Lab., Oak Ridge, TN). pp 891-929 of Physics of plasma-wall interactions in controlled Fusion. Post, D.E.; Behrisch, R. New York, NY; Plenum Press (1984). (CONF-8407172—).

From NATO advanced study institute on physics of plasma-wall interactions in controlled fusion; Val-Morin, Quebec, Canada (30 Jul 1984).

This paper provides a synopsis of major concepts of mechanical pump limiters and magnetic ergodic limiters/divertors. The principles of pump limiter operation and pump limiter design are discussed. Particle exhaust and pumping considerations are reviewed. The authors note that for impurity control, pump limiters seem to be inferior to magnetic divertors. The impurities originated at the limiter itself are examined. The authors examine prospects for fusion reactor applications in which pump limiters or divertors would fulfill heat removal, density control, helium ash removal, and impurity control tasks.

# 99 GENERAL AND MISCELLANEOUS

22045 **(DOE/MA—0288) Listing of awardee names: Inactive awards as of January 29, 1987.** (USDOE Assistant Secretary for Management and Administration, Washington, DC. Procurement and Assistance Management Directorate). 29 Jan 1987. 483p. NTIS, PC A21/MF A01; 1; GPO Dep. File Number DE87005444.

This is a computerized listing issued quarterly from the Procurement and Assistance Data System (PADS), including an alphabetical listing of all acquisition and financial assistance awards (excluding purchase orders) with the Department of Energy. Inactive is defined as the completion date of the award is earlier (in the past) than the date of the issuance of the listing.

22046 **(DOE/METC—87/6074) Morgantown Energy Technology Center: Publications list, FY 86.** Sink, C.H.; Pasini, S.E. (USDOE Morgantown Energy Technology Center, WV). Dec 1986. 132p. NTIS, PC A07/MF A01; GPO Dep. File Number DE87001020.

This Publications List includes the scientific and technical documents, papers, and presentations authored by the Morgantown Energy Technology Center (METC) staff as well as those written by METC contractors during Fiscal Year 1986. The documents, papers, and presentations are arranged by METC areas of expertise: Arctic and Offshore; Components; Computers, Modeling, and Simulation; Enhanced Oil Recovery; Environment; Fluidized-Bed Combustion; Fuel Cells; Gas Stream Cleanup; Gasification; Heat Engines; Instrumentation and Control; Low-Rank Coal; Oil Shale; Tar Sands; Unconventional Gas Recovery; Underground Coal Gasification; and Crosscutting Technologies. The reports are subarranged by identification numbers from the Energy Data Base. Author/corporate author, report number, and title indexes follow.

22047 **Normal accidents.** Perrow, C. New York, NY; Basic Books (1984). 386p.

From review by Larry Hirschhorn, Univ. of Pennsylvania, in Science, Vol. 228 (17 May 1985).

The book Normal Accidents, by Charles Perrow is reviewed. The book examines the ways in which complex technological systems fail and argues that people are intrinsically unable to build, manage and maintain modern technologies. Accidents in several different types of activities are examined in detail as support for this conclusion. The reviewer disagrees with Mr. Perrow's conclusion.

## 9901 Management

*REFER ALSO TO CITATION(S) 20820*

22048 **(INIS-mf—10495-Vols.1-2) Feasibility study for the Nuclear Research Centre of the Nuclear Energy Commission.** (Comision Nacional de Energia Atomica, Montevideo (Uruguay)). 1985. 488p. (In Spanish). NTIS (US Sales Only), PC A21/MF A01. File Number DE87701491.

The feasibility study was carried out in order to evaluate the possibility of building a Nuclear Research Centre in Uruguay, which would support a wide range of nuclear related technological activities. A market research was carried out, of the products to be manufactured at the Nuclear Centre, regarding the size of production. A detailed list of the main products considered is enclosed. The siting study was performed through the analysis of the incidental factors, such as environment, technical scope and socio-ecomonic factors. An engineering study for the main installations was done. The investment and financial sources were also studied.

22049 (INIS-mf—10574, pp 13-17) **Activities of consultancy centre for ionizing radiation applications.** Teply, J.; Bartonicek, B. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1985. (In Czech). NTIS (US Sales Only), PC A05/MF A01. File Number DE87701448. (CONF-8506335—Pt.4).

From Scientific and technical conference on the occasion of the 30th anniversary of the Czechoslovak Nuclear Research Institute; Rez, Czechoslovakia (6 Jun 1985).

The consultancy centre for ionizing radiation applications has been established within the radiation chemistry department at the Nuclear Research Institute at Rez. It is equipped with two well-type /sup 60/Co gamma irradiation devices of an activity of about 300 and 280 TBq, an electron accelerator for pulse radiolysis, and an accelerator for technological irradiation (3 MeV/1.2 kW), both products by Tesla. The centre provides irradiation services, chemical and technical expertise and is involved in the solution of research problems, this independently or in cooperation with other institutions.

22050 **(IPPJ-DT—117) Development of retrieval, reservation and management system for measuring instruments.** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Aug 1985. 41p. (In Japanese). NTIS (US Sales Only), PC A03/MF A01. File Number DE87700959.

In order to computerize the lending and management of measuring instruments, at first, the specification of the software was examined, but thereafter, the development was begun. The largest aim of the computerization was the automation and labor saving of the lending works of diverse measuring instruments and the automatic management. From user side, it is desirable to know the specification and the state of use and reservation of measuring instruments and to be able to easily make reservation based on the information. Besides, from management side, it is desirable to know the location and the state of use and reservation of measuring instruments, to immediately prepare for lending and returning, and to automate the recording of lending and returning. So as to satisfy those conditions, the automatic reservation and management system for measuring instruments was developed. At the same time, the means to simply input required data such as specification, names of manufacturers and equipment number was developed. The input of data was carried out for three months from October, 1984, and the system was almost completed in December, 1984. The full scale operation was started in January, 1985. (Kako, I.).

22051 **(PPA-T—20) Secondary Standard Dosimetry Laboratory (SSDL).** (Unit Tenaga Nuklear, Bangi, Selangor (Malaysia)). 1983. 23p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87701492.

A secondary Standard Dosimetry Laboratory has been established in the Tun Ismail Research Centre, Malaysia as a national laboratory for reference and standardization purposes in the field of radiation dosimetry. This article gives brief accounts on the general information, development of the facility, programmes to be carried out as well as other information on the relevant aspects of the secondary standard dosimetry laboratory.

## 9902 Mathematics And Computers

*REFER ALSO TO CITATION(S) 20328, 20329, 20330, 20374, 20404, 21200*

22052 **(AD-A—175121/3/XAB) Sparse elimination on vector multiprocessors. Interim report, 1 May 1985-30 April 1986.** Calahan, D.A. (Michigan Univ., Ann Arbor (USA). Dept. of Electrical Engineering and Computer Science). 15 Apr 1986. 7p. NTIS, PC A02/MF A01.

The availability of instruction-level simulators for the CRAY X-MP and the CRAY-2, together with early access to the MFECC and NAS CRAY-2s, has made possible the study of a variety of equation-solving issues for many-processor VMP configurations. These include: (1) the development of equation-solving algorithms on the CRAY-2, and; (2) task granularity studies; and (3) memory conflict studies.

22053 **(AD-A—175148/6/XAB) Design guidelines for a rule-based passive surveillance system. Master's thesis.** Jennings, K.E. (Naval Postgraduate School, Monterey, CA (USA)). Sep 1986. 51p. NTIS, PC A04/MF A01.

This thesis addresses the application of artificial intelligence to passive surveillance systems that use waveform analysis as their primary means of detecting, classifying, and locating a specific target. Discussion is further limited to those passive surveillance systems which must deal with considerable noise in the data. Present methods, which use visual examination of the waveform data for the detection of target waveforms, is complicated, time consuming, and requires considerable expertise. The lack of prior knowledge of the nature of the noise, (e.g., frequency spectra, amplitude, or dynamics), means that the majority of signal analysis must be done by experts. This study discusses and recommends a rule-based system which uses the following artificial-intelligence structures: the blackboard architecture, and the frames data structure. Sources of uncertainty are also discussed and methods of dealing with it are suggested. This study recommends that the symbolic representation language be carefully selected for conciseness, efficiency, and a vocabulary rich enough to express everything desired by the experts. A learning knowledge source is also recommended.

22054 **(AD-A—175239/3/XAB) Development of programming techniques for SIMD computers. Annual progress report No. 2.** Potter, J.L. (Kent State Univ., OH (USA). Dept. of Mathematical Sciences). 15 Oct 1986. 35p. NTIS, PC A03/MF A01.

During the past fiscal year, this research grant helped support activities in four related areas of associative programming: 1) implementation of the ASPROL compiler; 2) implementation of the FIRST, NEXT, PREVIOUS, TRUNC and TRUNCA acode functions and I/O stack routines; 3) implementation of the associative database primitives; and 4) analysis of new network designs for interprocessor communications in associative processors. It is felt that this compiler can be augmented with rule-based constructs that will provide a high performance expert system capability. The ASPROL high-level language developed last year and described in last years report was implemented on the KSU VAX 780 research computer.

22055 **(AD-A—175260/9/XAB) Serial-bus architecture for parallel-processing systems. Master's thesis.** Delaney, K.J. (Naval Postgraduate School, Monterey, CA (USA)). Sep 1986. 64p. NTIS, PC A04/MF A01.

One of the most-serious deterrents to the development of multiple-processor architectures has been the problem of providing adequate communication between the discrete processing elements. This thesis examine two communications-based constraints. The first constraint is related to the physical structure of the VLSI chip. The wider the communication path the more pins are needed to effect the data transfer. As integrated circuits grow in computational power, more communication capacity is needed, pushing designs closer to the pin limitation of the packaging technology. The second constraint, somewhat related to the first, is the limited speed with which data can be transmitted via internal channels. Typical speeds one can achieve on a single wire are on the order of 1 Gbps. The recent development of an optoelectronic multiplexer may allow VLSI chips to communicate at rates up to 7 Gbps. An architecture for a parallel-processing computer that takes advantage of this new capability is presented. The feasibility is presented. The feasibility of a single-chip parallel-processor based on the Optoelectronic Multiplexer is examined by projecting current trends in processor speed, power, and transistor count into estimates of throughput for a multiprocessor IC.

22056 **(ANL/MCS-TM—84) Use of vector and parallel computers in the solution of large, sparse linear equations.** Duff, I.S. (Argonne National Lab., IL (USA). Mathematics and Computer Science Div.). Nov 1986. Contract W-31109-ENG-38. 16p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87006194.

We discuss the direct solution of large, sparse linear equations on vector and parallel computers. To be specific, we examine algorithms based on Gaussian elimination for solving the equation $Ax=b$, when the coefficient matrix A is unsymmetric, large, and sparse. We will look at three classes of algorithms and comment on how effective they are at exploiting vector and parallel architectures. The classes into which we divide our algorithms are general methods, band and frontal techniques, and multifrontal approaches. 32 refs., 2 figs., 5 tabs.

22057 **(ANL/TM—447) Report of the Computer-Aided Engineering Integration Project.** Raffenetti, R.C.; Amber, R.A.; Bertoncini, P.J.; Cook, J.M.; Mandel, J.H.; McMahon, R.J.; Vander Mast, S.K.; Volmer, J.A. (Argonne National Lab., IL (USA)). Feb 1987. Contract W-31109-ENG-38. 40p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87006790.

Goal of this project is to investigate, evaluate, and recommend the networking methods and the data exchange standards by which integration of the Intergraph design equipment and other computer-based Laboratory systems will be achieved. Personal computer-based design systems, computer-integrated manufacturing, engineering analysis, graphics output, electronic publishing, applications data interfaces and data communications options are covered.

22058 **(CONF-870150—1) Alternative knowledge acquisition: Developing a pulse coded neural network.** Dress, W.B. (Oak Ridge National Lab., TN (USA)). Jan 1987. Contract AC05-84OR21400. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005192.

From Long Island University computer technology symposium; Brookville, NY, USA (23 Jan 1987).

After a Rip-van-Winkle nap of more than 20 years, the ideas of biologically motivated computing are re-emerging. Instrumental to this awakening have been the highly publicized contributions of John Hopfield and major advances in the neurosciences. In 1982, Hopfield showed how a system of maximally coupled neutron-like elements described by a Hamiltonian formalism (a linear, conservative system) could behave in a manner startlingly suggestive of the way humans might go about solving problems and retrieving memories. Continuing advances in the neurosciences are providing a coherent basis in suggesting how nature's neurons might function. A particular model is described for an artificial neural system designed to interact with (learn from and manipulate) a simulated (or real) environment. The model is based on early work by Iben Browning. The Browning model, designed to investigate computer-based intelligence, contains a particular simplification based on observations of frequency coding of information in the brain and information flow from receptors to the brain and back to effectors. The ability to act on and react to the environment was seen as an important principle, leading to self-organization of the system.

**22059 (FNAL-TM—1427) Review of the status of the FASTBUS standard routine specification.** Pordes, R. (Fermi National Accelerator Lab., Batavia, IL (USA)). Nov 1986. Contract AC02-76CH03000. 9p. (CONF-861007—24). NTIS, PC A02/MF A01; GPO Dep. File Number DE87004228.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

Within the next few months the FASTBUS Software Working group hopes to distribute the Specification for Standard Routines for FASTBUS. The draft specification will go to the members of the overseeing NIM committee for review. This paper presents the current status of the specification. It includes a list of the goals of the specification; some details of the concepts embedded in it; as well as an overview of the software implementations of the previously distributed draft versions of the specification.

**22060 (IAE—1971/E-3/R/B) One-dimensional SNAIL computer code for the reactor rigs and other multilaminar cylindrical systems heat analysis.** (Institute of Atomic Energy, Otwock-Swierk (Poland)). 1983. 40p. (In Polish). Power System Computer Centre. Mining and Power System Information Department, Palace of Culture and Science, PL-00-901 Warsaw, Poland.

FORTRAN EXTENDED for CYBER 73.

The suitability is presented of the one-dimensional heat transfer model in reactor rigs heat computations. The structure and functioning of the SNAIL program which realizes such a model are discussed. The results of experimental verification of the code are presented. The program is comparatively universal - it can be used for heat computations of all the multilaminar cylindrical geometry systems which fulfill the assumptions made in the paper. The most essential feature of the code is that it effectively considers thermal dilatations of each layer.

**22061 (IFVE-OMVT—85-118) REDUCE program for the calculation of the geometrical characteristics of compactified multidimensional Riemannian space.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87700899.

Submitted to the journal Comp. Phys. Comm. .

The REDUCE program for calculation of the connection, curvature, Ricci tensor etc. for the group quotient space is described. The knowledge of these quantities is necessary for creation of unified models of fundamental interactions in the framework of multidimensional generally covariant field theories. 12 refs.; 1 tab.

**22062 (INP—1228/AP) BALTORO a general purpose code for coupling discrete ordinates and Monte-Carlo radiation transport calculations.** (Institute of Nuclear Physics, Krakow (Poland)). 1983. 81p. NTIS (US Sales Only), PC A05/MF A01. File Number DE87701490.

CDC computer 6600(7600), FORTRAN.

The general purpose code BALTORO was written for coupling the three-dimensional Monte-Carlo /MC/ with the one-dimensional Discrete Ordinates /DO/ radiation transport calculations. The quantity of a radiation-induced /neutrons or gamma-rays/ nuclear effect or the score from a radiation-yielding nuclear effect can be analysed in this way.

**22063 (INR—1960/9/R/B) Modification of the TESP code system: application of the deformed quadrangle mesh.** (Institute of Nuclear Research, Warsaw (Poland)). 1983. 20p. (In Polish). Power System Computer Centre. Mining and Power System Information Department, Palace of Culture and Science, PL-00-901 Warsaw, Poland.

FORTRAN EXT/CDC-CYBER 72.

Some alterations to the TESP programme system are presented. These alterations enable calculation of the temperature and stress distribution in the areas where the boundaries and the material separation lines consist of segments and arcs of circle.

**22064 (JAERI—1301) THIDA-2: an advanced code system for calculation of transmutation, activation, decay heat and dose rate.** (Japan Atomic Energy Research Inst., Tokyo). Mar 1986. 123p. NTIS (US Sales Only), PC A06/MF A01. File Number DE87701000.

In a D-T burning fusion reactor, the radioactivity induced by the 14 MeV neutrons causes many problems. It limits personnel access to the reactor during shutdown, generates decay heat and produces radwastes. A code system THIDA had been developed in 1978 to calculate the radioactivity and dose rate around a fusion device. The THIDA system consisted of the followings: one- and two-dimensional discrete ordinates radiation transport codes; induced activity calculation code; three libraries for transmutation and decay chain data, transmutation cross sections and delayed gamma-ray emission data. The present report gives a complete description of THIDA-2, a new advanced version of the THIDA system which has the following major improvements: 1. Capability to treat three-dimensional calculation models by the use of a Monte Carlo transport code. 2. Accurate decay heat calculation following the transport of delayed gamma rays. 3. Simplification of the data input process by the use of free format scheme and closer coupling between the radiation transport codes and the induced activity calculation code. 4. Self-descriptive output format and additional plotter output. 5. Capability to calculate problems requiring larger core memory by the use of variable dimension.

**22065 (JAERI-M—86-010) Function and organization of CPC database system.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1986. 112p. (In Japanese). NTIS (US Sales Only), PC A06/MF A01. File Number DE87701022.

It is very time-consuming and expensive work to develop computer programs. Therefore, it is desirable to effectively use the existing program. For this purpose, it is required for researchers and technical staffs to obtain the relevant informations easily. CPC (Computer Physics Communications) is a journal published to facilitate the exchange of physics programs and of the relevant information about the use of computers in the physics community. There are about 1300 CPC programs in JAERI computing center, and the number of programs is increasing. A new database system (CPC database) has been developed to manage the CPC programs and their information. Users obtain information about all the programs stored in the CPC database. Also users can find and copy the necessary program by inputting the program name, the catalogue number and the volume number. In this system, each operation is done by menu selection. Every CPC program is compressed and stored in the database; the required storage size is one third of the non-compressed format. Programs unused for a long time are moved to magnetic tape. The present report describes the CPC database system and the procedures for its use.

**22066 (LA—10883-MS) FORTRAN compiler performance benchmarks for the IBM personal computer.** Ballmann, J.S.; Wilkerson, J.F. (Los Alamos National Lab., NM (USA)). Feb 1987. Contract W-7405-ENG-36. 29p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87006319.

The relative performance of various FORTRAN compilers has been measured. The AT and XT models of the IBM peronal computer using the PCDOS operating system were used to evaluate three currently available compilers. Results are summarized and the characteristics of each compiler are presented. 11 refs.

**22067 (LA-UR—86-4336) Implementing remote procedure calls with DECnet.** Bjorklund, E.; Schaller, S.C. (Los Alamos National Lab., NM (USA)). 1987. Contract W-7405-ENG-36. 17p. (CONF-870471—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87003754.

From DECUS spring meeting; Nashville, TN, USA (27 Apr 1987).

The "Remote Procedure Call" (RPC) has recently become an important communication model for distributed systems. The basic idea behind remote procedure calls is that a process running on one machine can "call", using standard procedure calling semantics, another routine that executes on a different machine. A message-passing mechanism is used to transfer parameters between the caller and the called routine. In this paper, we describe a remote

procedure call system we have implemented that uses DECnet as the underlying message-passing mechanism. Our system is highly reliable, reasonalbly efficient, and supports some advanced features such as asynchronous remote procedures. The described system is currently part of a distributed accelerator-control system containing VMS, Micro-VMS, and VAXELN nodes. It could also be extended to any other system that supports DECnet. Topics discussed include the system design, parameter-passing protocol, error detection and recovery, and performance.

22068 **(LA-UR—87-140) Nonlinear response matrix methods for radiative transfer.** Miller, W.F. Jr.; Lewis, E.E. (Los Alamos National Lab., NM (USA); Northwestern Univ., Evanston, IL (USA)). 1987. Contract W-7405-ENG-36. 16p. (CONF-870424—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005106.

From American Nuclear Society international meeting on advances in reactor physics, mathematics and computation; Paris, France (27 Apr 1987).

A nonlinear response matrix formalism is presented for the solution of time-dependent radiative transfer problems. The essential feature of the method is that within each computational cell the temperature is calculated in response to the incoming photons from all frequency groups. Thus the updating of the temperature distribution is placed within the iterative solution of the spaceangle transport problem, instead of being placed outside of it. The method is formulated for both grey and multifrequency problems and applied in slab geometry. The method is compared to the more conventional source iteration technique. 7 refs., 1 fig., 4 tabs.

22069 **(M—194) Writing Basis packages.** Dubois, P.F. (Lawrence Livermore National Lab., CA (USA)). 18 Nov 1986. Contract W-7405-ENG-48. 39p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006827.

The Basis Language is the user interface for programs using the Basis system. This language is a fully featured programming language with the additional property that the variables in the common blocks of the physics packages are accessible and can appear in user statements. Thus, statements of the Basis Language set or display the variables in the physics packages, plot them, save them to files, etc. This manual contains the documentation for the development system.

22070 **(N—87-14247) Techniques to achieve high-speed computations in supercomputers.** Watanabe, T. (National Aerospace Lab., Chofu, Tokyo (Japan)). Nov 1985. vp. (NAL-SP—5). NTIS, PC A12/MF A01.

Various techniques to achieve high-speed computations in supercomputers are described. In particular, architectural approaches to augment concurrency are described. Those approaches include multiprocessors, parallel processors, and pipelined processors. A multiprocessor system is one in which plural processors share the main memory and different programs are executed on each processor. The multiprocessor enhances the system throughput by the concurrent execution of programs. In a parallel processor system, plural processors are connected to each other directly or through a memory unit, and all the processors execute the identical instruction simultaneously under the control of the control unit. In a pipelined processor, instruction execution is streamlined like an assembly line of an automobile factory or the processing procedure in a chemical plant. Next, vector processing for achieving high-speed computations is outlined. Finally, as an example of supercomputers, the vector processing feature of the NEC supercomputer SX system is introduced. The SX system employs multiple-parallel pipelines and 512 way-interleaved memory system to achieve a vector processing speed of 1.3 G flops.

22071 **(ORNL—6362) International symposium on methodologies for intelligent systems: Colloquia program: Proceedings.** Zemankova, M.; Emrich, M.L. (eds.). (Tennessee Univ., Knoxville (USA); Oak Ridge National Lab., TN (USA); Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); North Carolina Univ., Charlotte (USA); Procter and Gamble Co., Cincinnati, OH (USA); Association for Computing Machinery, New York (USA). Special Interest Group on Artificial Intelligence). Jan 1987. Contract AC05-84OR21400. 163p. (CONF-8610193—). NTIS MF A01; 2; GPO Dep. File Number DE87006025.

From International colloquia on methodologies for intelligent systems; Knoxville, TN, USA (25 Oct 1986).

Individual papers have been cataloged separately. (WRF)

22072 **(PB—87-124400/XAB) Scientific data manipulation in a relational data-base system.** Read, B.J. (Rutherford Appleton Lab., Chilton (UK)). Jul 1986. 10p. (RAL—86-084). NTIS, PC PC E03/MF E03.

Provided the user interface is well designed, extended relational algebra can be a powerful tool for handling scientific data. Its utility is greatly enhanced by the addition of attribute algebra to allow mathematical manipulation of field values. The paper reports on a development which, motivated by practical requirements, integrates features such as functions, vector data types, iteration, and conditional-attribute values into a relational data-base management system.

22073 **(SAND—86-2453) Elements of a proposed security methodology for networks of computers.** Pierson, L.G.; Witzke, E.L. (Sandia National Labs., Albuquerque, NM (USA)). Oct 1986. Contract AC04-76DP00789. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006769.

In this document we describe the components or elements of a proposed security methodology for networks of computers. This general security methodology separates the "security life" of a computer network into two phases; the design, review, and accreditation phase, and the operational phase. The first phase deals with system security planning, implementation, certification, and accreditation for operation. The second phase deals with the processing of unusual events which may be of security interest during the operation of a computer network. The unusual events are processed through a series of "filters" to determine if the event is associated with a loss or unauthorized activity. Detection and processing of certain kinds of unusual events may cause the update and review of the elements in the first phase (design, review, and accreditation).

22074 **(SLAC-PUB—4148) Networking through the new phone system: The future of telecommunications.** Struven, W. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Dec 1986. Contract AC03-76SF00515. 9p. (CONF-870249—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87004558.

From Computing high energy physics; Pacific Grove, CA, USA (2 Feb 1987).

The history of the telephone system is traced from 1850 to present, and the "new" telephone companies are described. The immediate problems of 56 KB data and 64 KB voice channels are discussed together with their proposed solution. The Integrated Digital System Network concept (IDSN) is described, and the proposals to build a true end-to-end digital telephone network are described. The Stanford University-Northern Telecom information test facility is described. The current and planned networks in the US and around the world have also been included.

22075 **(UCID—20709) New Application Language Committee: Final report.** Blair, G.J.; Chase, L.; Cook, L.M.; Moura, J.E. (Lawrence Livermore National Lab., CA (USA)). Oct 1986. Contract W-7405-ENG-48. 131p. NTIS, PC A07. File Number DE87005929.

A modern language can revolutionize programming at the Laboratory. The New Applications Language Committee recommends that the Laboratory complete the language study and selection, begin aggressive education and training in modern languages, acquire Ada compilers to encourage experimentation, monitor and

influence the standardization and revision of Ada and Fortran 8X, and implement the selected language. This report discusses the strengths of Ada, problem areas for scientific application, and mixed language issues. It also documents for future reference learning experiences with the Ada Language.

22076 **Bifurcated method and apparatus for floating point addition with decreased latency time.** Farmwald, P.M. (to Dept. of Energy, Washington, DC). US Patent 4,639,887. 27 Jan 1987. Filed date 24 Feb 1984. vp.

This patent describes a method for performing floating point addition of a pair of floating point binary numbers each expressed as a mantissa and an exponent. The method comprises the steps of alignment of the mantissas, addition of the aligned mantissas and postnormalization of the mantissa of the sum. The improvement described here comprises: comparing the exponents of the two floating point numbers prior to the alignment step; simultaneously performing two separate calculations along first and second separate parallel paths as follows: calculating a first sum in the first path as if the difference of the exponents is either 0 or 1, including performing the alignment step by at most a one place right shift of one mantissa; simultaneously calculating a second sum in the second path as if the difference of the exponents is greater than 1, including performing the postnormalization step by at most a one place shift of the mantissa of the second sum; selecting between the first sum and the second sum after simultaneously performing the two calculations.

22077 **Perspectives on artificial intelligence programming.** Bobrow, D.G.; Stefik, M.J. (Xerox Palo Alto Research Center, CA). *Science (Washington, D.C.);* **231**: 951-956(28 Feb 1986).

Programs are judged not only by whether they faithfully carry out the intended processing but also by whether they are understandable and easily changed. Programming systems for artificial intelligence applications use specialized languages, environments, and knowledge-based tools to reduce the complexity of the programming task. Language styles based on procedures, objects, logic, rules, and constraints reflect different models for organizing programs and facilitate program evolution and understandability. To make programming easier, multiple styles can be integrated as sublanguages in a programming environment. Programming environments, provide tools that analyze programs and create informative displays of their structure. Programs can be modified by direct interaction with these displays. These tools and languages are helping computer scientists to regain a sense of control over systems that have become increasingly complex. 36 references, 3 figures.

22078 **Knowledge-based systems.** Davis, R. (Massachusetts Institute of Technology, Cambridge). *Science (Washington, D.C.);* **231**: 957-963(28 Feb 1986).

First developed two decades ago, knowledge-based systems have seen widespread application in recent years. While performance has been a strong focus of attention, building such systems has also expanded the authors conception of a computer program from a black box providing an answer to something capable of explaining its answers, acquiring new knowledge, and transferring knowledge to students. These abilities derive from distinguishing clearly what the program knows from how that knowledge will be used, making it possible to use the same knowledge in different ways. 44 references, 1 figure.

22079 **High performance execution of Prolog programs based on a Static Data Dependency Analysis.** Chang, J.H. Berkeley, CA; Univ. of California (1985). 157p. University Microfilms Order No. 86-09,970.

Thesis (Ph. D.).

Prolog programs are executed from left-to-right and top-to-bottom with backtracking to the most recently activated choicepoint when a failure occurs. This execution strategy is based on a sequential execution model and has been implemented with most efficiency in conventional computer systems. In this thesis, two ways are explored to improve the performance of a Prolog system. The first way is a more intelligent form of backtracking. The second way is to exploit AND-parallel execution. Both intelligent backtracking and AND-parallel execution require information about the dependency between body literals. This information can be derived either at compile time by using a static analysis or at run-time. A methodology for a Static Data Dependency Analysis (SDDA) was developed. The SDDA is based on a worst-case analysis of variable bindings. To perform the SDDA, only one declaration, which describes the worst-case activation, is necessary for each procedure which can be directly invoked from the top level query. A scheme for compiling intelligent backtracking based on the SDDA was designed. To take full advantage of dependency graphs, three different types of backtracking are differentiated. A scheme to exploit AND-parallelism is also proposed. It includes generating parallel executable tasks by the SDDA, using a set of message protocols to coordinate co-operating processes, exploiting both intelligent backtracking and parallel backtracking.

22080 **Design and descriptive tools for systolic architectures.** Lewis, P.S. (Los Alamos National Lab., NM). *Proceedings of the Society of Photo-Optical Instrumentation Engineers;* **495**: 67-74(1984).

From Real time signal processing VII; San Diego, CA, USA (21-22 Aug 1984).

Automated design and descriptive tools are essential for the practical application of highly parallel special-purpose hardware such as systolic arrays. The use of special-purpose hardware can greatly increase the capabilities of signal processing systems. However, the more limited applications base makes design costs a critical factor in determining technical and economic viability. Systolic systems can be described at several levels of abstraction, each of which has unique descriptive requirements. This paper focuses on the descriptive issues involved at the system architectural level. Tools at this level must bridge the gap between logic- and circuit-oriented computer-aided design tools and algorithmic descriptions of systolic architectures. Traditionally, hardware description languages (HDLs) have been used at this level to describe conventional computer architectures. Systolic architectures, however, have different requirements. This paper examines these requirements and develops a set of criteria for evaluating HDLs. Four popular DHLs are evaluated and their strengths and weaknesses noted. The final section of the paper summarizes ongoing efforts at Los Alamos to develop a systolic array HDL based on the CONLAN family of languages. 14 references.

## 9903 Information Handling

*REFER ALSO TO CITATION(S) 21617, 22072*

22081 **(INIS-mf—10551) IAEA data base system for nuclear research reactors (RRDB).** (International Atomic Energy Agency, Vienna (Austria)). Jan 1986. 147p. NTIS (US Sales Only), PC A07/MF A01. File Number DE87700926.

The IAEA Data Base System for Nuclear Research Reactors (RRDB) User's Guide is intended for the user who wishes to understand the concepts and operation of the RRDB system. The RRDB is a computerized system recording administrative, operational and technical data on all the nuclear research reactors currently operating, under construction, planned or shut down in IAEA Member States. The data is received by the IAEA from reactor centres on magnetic tapes or as responses to questionnaires. All the data on research, training, test and radioactive isotope production reactors and critical assemblies is stored on the RRDB system. A full set of RRDB programs (in NATURAL) are contained at the back of this Guide. 11 figs.

## 9905 Civilian Defense

22082 **(ORNL—6252) Civil defense shelters: A state-of-the-art assessment, 1986.** Chester, C.V.; Zimmerman, G.P. (Oak Ridge National Lab., TN (USA)). Feb 1987. Contract AC05-84OR21400. 314p. NTIS, PC A14/MF A01; 1; GPO Dep. File Number DE87006023.

The literature on the design, construction, testing, and cost of blast and fallout shelters was reviewed, and a bibliography of over 1000 documents was assembled. It was found that nuclear

weapon effects and shelter design are well understood. An important barrier to construction of permanent shelters is cost. Single-purpose shelters cost in the high hundreds to low thousands of dollars per occupant (or per space), depending on size, hardness, location, and whether the shelter is part of new construction or retrofit. Multiplied by a risk area population of approximately 160 million, the cost of a blast shelter construction program would rival that of a major strategic weapon system. Options in the mid-range of expense, a few tens to a few hundreds of dollars per space include (1) requiring modified limestone mining practices, where appropriate, to generate usable shelter space near cities; (2) encouraging the construction of earth-sheltered housing and other buildings; and (3) requiring and/or subsidizing the construction of dual-use basement shelter in new construction. A program using this approach would require an annual expenditure of approximately 1% of the annual defense budget for 10 or more years. 950 refs., 68 figs., 9 tabs.

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In the Corporate Author Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

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DOE Energy Data Base: Corporate Author Entries (DOE/TIC-4585) is used in the standardization of corporate entries. DOE/TIC-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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The notations in the final parentheses indicate the type of document, e.g., R for Report; the country of publication, e.g., US; and the language if other than English, e.g., In German. Tables of document types and country of publication codes appear after the indexes.

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processes applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept (e.g., Pipeline Quality Gas, see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed. Copies of DOE/TIC-7000, the Subject Thesaurus, are available from the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161.

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*M CODES*
*S CODES*
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*See THERMAL CONDUCTIVITY*

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*See MEETINGS*

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| **AC08-83NV10282** | **EG and G Energy Measurements, Inc., Goleta, CA (USA). Santa Barbara Operations** | |
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| **FG02-85ER13322** | **Brooklyn Coll., NY (USA)** | |
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| **FG02-85ER13337** | **Yale Univ., New Haven, CT (USA). Dept. of Biology** | |
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| **FG02-86ER13473** | **Colorado Univ., Boulder (USA)** | |
| | 12:20534 | DOE/ER/13473—2 |
| **FG02-86ER13489** | **Rensselaer Polytechnic Inst., Troy, NY (USA)** | |
| | 12:20893 | DOE/ER/13489—1 |
| **FG02-86ER13553** | **Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.** | |
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| **FG02-86ER13560** | **United Technologies Research Center, East Hartford, CT (USA)** | |
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| **FG02-86ER53219** | **Pennsylvania State Univ., University Park (USA)** | |
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| **FG06-86ER13472** | **Washington Univ., Seattle (USA). Dept. of Geophysics** | |
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| 1 | *See* FRADOC-8-6 | DE87750996 | MN -78 | 12:20336 |
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| 6 | *See* BNL-39264 | E 1.99: DE87006464 | MN -90b | 12:19891 |
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| CONF-8602114- | (Workshop on dusty plasmas, San Diego, CA, USA, 10-11 Feb 1986) | | | |
| 1 | *See* N-87-14148 | | | 12:21301 |
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| CONF-860330- | (5. annual target fabrication specialists meeting, Las Vegas, NV, USA, 24-27 Mar 1986) | | | |
| 3 | *See* DOE/DP/40200-30 | E 1.99: DE87005915 | MN -21 | 12:21971 |
| CONF-860340- | (115. American Institute of Mining, Metallurgical and Petroleum Engineers annual meeting, New Orleans, LA, USA, 2-6 Mar 1986) | | | |
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| CONF-860393- | (Workshop on compact storage ring technology: applications to lithography, Upton, NY, USA, 4-5 Mar 1986) | | | |
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| 15 | *See* CEA-CONF-8493 | DE87750983 | MN -34D | 12:21522 |
| CONF-8603172- | (Governor's conference on indoor radon, Albany, NY, USA, 4-5 Mar 1986) | | | |
| 1 | *See* LBL-21641 | E 1.99: DE87003529 | MN -05 | 12:21111 |
| CONF-8603173- | (Symposium on marine biology of the Arabian Sea, Karachi, Pakistan, 29 Mar-2 Apr 1986) | | | |
| 1 | *See* BNL-38942 | E 1.99: DE87003233 | MN -11 | 12:21127 |
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| 23 | *See* N-87-14518 | | | 12:20636 |
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| CONF-860501- | (Conference on the science and technology of fast reactor safety, Channel Islands, UK, 12-16 May 1986) | | | |
| 18 | *See* CEA-CONF-8502 | DE87751024 | MN -79 | 12:20360 |
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| 23 | *See* GA-A-18418 | E 1.99: DE87005237 | MN -20d | 12:21978 |
| CONF-860548- | (8. international symposium on coal slurry fuels preparation and utilization, Orlando, FL, USA, 27-30 May 1986) | | | |
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| CONF-8605216- | (50. meeting of the French working group of dosimetry, Marcoule, France, 21-22 May 1986) | | | |
| 1 | *See* CEA-CONF-8507 | DE87751022 | MN -80 | 12:20373 |
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| | *See* ECE-COAL/GE.4/R.29/Add.8 | | | 12:19893 |
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| | *See* ECE-COAL/GE.4/R.29/Add.5 | | | 12:19936 |
| | *See* ECE-COAL/GE.4/R.31/Add.5 | | | 12:19937 |
| | *See* ECE-COAL/GE.4/R.31/Add.4 | | | 12:19938 |
| | *See* ECE-COAL/GE.4/R.31/Add.3 | | | 12:19939 |
| | *See* ECE-COAL/GE.4/R.29/Add.4 | | | 12:19940 |
| | *See* ECE-COAL/GE.4/R.29/Add.3 | | | 12:19941 |
| | *See* ECE-COAL/GE.4/R.29/Add.1 | | | 12:19942 |
| | *See* ECE-COAL/GE.4/R.20/Add.12 | | | 12:19943 |
| | *See* ECE-COAL/GE.4/R.31/Add.2 | | | 12:19944 |
| | *See* ECE-COAL/GE.4/R.20/Add.6/Supp.1 | | | 12:19945 |
| | *See* ECE-COAL/GE.4/R.20/Add.7/Sup.1 | | | 12:19946 |
| | *See* ECE-COAL/GE.4/R.20/Add.11 | | | 12:19947 |
| | *See* ECE-COAL/GE.4/R.22/Add.12 | | | 12:19948 |
| | *See* ECE-COAL/GE.4/R.20/Add.5/Suppl.1 | | | 12:19949 |
| | *See* ECE-COAL/GE.4/R.20/Add.9 | | | 12:19950 |
| | *See* ECE-COAL/GE.4/R.20/Add.10 | | | 12:19951 |
| | *See* ECE-COAL/GE.4/R.22/Add.9 | | | 12:19952 |
| | *See* ECE-COAL/GE.4/R.22/Add.10 | | | 12:19953 |
| | *See* ECE-COAL/GE.4/R.22/Add.11 | | | 12:19954 |
| | *See* ECE-COAL/GE.4/R.22/Add.8 | | | 12:19955 |
| | *See* ECE-COAL/GE.4/R.31/Add.1 | | | 12:19956 |
| CONF-860629- | (Linear accelerator conference, Stanford, CA, USA, 2-6 Jun 1986) | | | |
| 64 | *See* CEA-CONF-8527 | DE87751007 | MN -28 | 12:20953 |
| 65 | *See* CEA-CONF-8528 | DE87751008 | MN -28 | 12:20941 |
| CONF-860680- | (CPEM conference, Gaithersburg, MD, USA, 23-27 Jun 1986) | | | |
| 2 | *See* K/TS-11793 | E 1.99: DE87003310 | MN -38 | 12:20833 |
| CONF-8606142- | (2. joint US Army SDC/BNL neutralizer workshop, Upton, NY, USA, 17-18 Jun 1986) | | | |
| 4 | *See* BNL-39022 | E 1.99: DE87005249 | MN -34A | 12:21419 |
| CONF-8606164- | (8. international seminar on high energy physics problems, Dubna, USSR, 19-24 Jun 1986) | | | |
| 3 | *See* BONN-HE-86-15 | DE87751280 | MN -34D | 12:21521 |
| CONF-8606183- | (NATO international advanced course on physics of strong fields, Maratea, Italy, 1-14 Jun 1986) | | | |
| 10 | *See* LBL-22072 | E 1.99: DE87000937 | MN -34D | 12:21675 |

| Report Number | Availability Source | File Number | Distribution Category | Abstract Number |
|---|---|---|---|---|
| CONF-8606215- | (Summer study on the physics of the superconducting super collider, Snowmass, CO, USA, 23 Jun-11 Jul 1986) | | | |
| 34 | *See* DOE/ER/40272-18 | E 1.99: DE87005676 | MN -34D | 12:21524 |
| 36 | *See* DOE/ER/40272-24 | E 1.99: DE87005678 | MN -34D | 12:21525 |
| CONF-8606247- | (GRECO-ILM seminar, Oleron, France, 23-25 Jun 1986) | | | |
| 1 | *See* CEA-CONF-8534 | DE87751037 | MN -25 | 12:20852 |
| 2 | *See* CEA-CONF-8535 | DE87751038 | MN -25 | 12:20853 |
| CONF-8606252- | (Brightness and coherence of synchrotron radiation and high-gain free electron lasers, Novosibirsk, USSR, 3-5 Jun 1986) | | | |
| 1 | *See* LBL-22317 | E 1.99: DE87003525 | MN -38 | 12:20855 |
| CONF-8606261- | (17. international GIFT seminar on cosmology and particle physics, Peniscola, Spain, 2-7 Jun 1986) | | | |
| 1 | *See* DOE/ER/40272-28 | E 1.99: DE87005680 | MN -34D | 12:21526 |
| CONF-8606263- | (International summer school on nuclear phase transitions and heavy ion reactions, Changkhun, China, 18 Jun-1 Jul 1986) | | | |
| 1 | *See* LBL-22072 | E 1.99: DE87000937 | MN -34D | 12:21675 |
| CONF-8606270- | (Surface activity, colloid and interfacei property and industrial applications conference, Belgirate, Italy, 9-13 Jun 1986) | | | |
| 1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87002175 | MN -92a | 12:19969 |
| CONF-8606280- | (International symposium on fluid dynamics and space, Rhode-Saint-Genese, Belgium, 25-26 Jun 1986) | | | |
| | *See* ESA-SP-65 | | | 12:20895 |
| CONF-860701- | (23. international conference on high-energy physics, Berkeley, CA, USA, 16-23 Jul 1986) | | | |
| 72 | *See* LA-UR-86-3228 | E 1.99: DE87000155 | MN -34D | 12:21508 |
| CONF-860720- | (Quarks and galaxies: theoretical workshop on cosmology and particle physics, Berkeley, CA, USA, 28 Jul-1 Aug 1986) | | | |
| 2 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87004575 | MN -34B | 12:21292 |
| CONF-860736- | (SLAC summer institute on particle physics, Stanford, CA, USA, 29 Jul-9 Aug 1986) | | | |
| 7 | *See* SLAC-PUB-4153 | E 1.99: DE87004899 | MN -34D | 12:21512 |
| 8 | *See* SLAC-PUB-4151 | DE87005957 | MN -34D | 12:21392 |
| CONF-860741- | (International symposium on weak and electromagnetic interactions in nuclei, Heidelberg, F.R. Germany, 1-5 Jul 1986) | | | |
| 22 | *See* CEA-CONF-8579 | DE87751021 | MN -80 | 12:21523 |
| CONF-860753- | (International conference on EXAFS and near edge structure, Saumur, France, 7-11 Jul 1986) | | | |
| 8 | *See* CEA-CONF-8680 | DE87751682 | MN -25 | 12:20178 |
| CONF-8607112- | (Interstellar processes conference, Jackson, WY, USA, 3-7 Jul 1986) | | | |
| Absts. | *See* N-87-15043 | | | 12:21302 |
| CONF-8607116- | (16. annual anomalous absorption conference, Lake Luzerne, NY, USA, 13-18 Jul 1986) | | | |
| 1 | *See* DOE/DP/40200-32 | E 1.99: DE87005917 | MN -21 | 12:21973 |
| CONF-860802- | (International nuclear physics conference, Harrogate, UK, 25-30 Aug 1986) | | | |
| 13-Summ. | *See* CEA-CONF-8566 | DE87751042 | MN -34C | 12:21639 |
| CONF-860832- | (11. international conference on few-body systems in particle and nuclear physics, Tokyo, Japan, 24-30 Aug 1986) | | | |
| 10 | *See* SLAC-PUB-4119 | E 1.99: DE87004897 | MN -34C | 12:21627 |
| CONF-860866- | (Gordon research conference on photonuclear reactions, Plymouth, NH, USA, 4-8 Aug 1986) | | | |
| 1 | *See* CEA-CONF-8544 | DE87751039 | MN -28 | 12:21618 |
| CONF-860880- | (30. SPIE technical symposium on optics and optoelectronic engineering, San Diego, CA, USA, 17-22 Aug 1986) | | | |
| 47 | *See* PNL-SA-14175 | DE87006400 | MN -34A | 12:21752 |
| CONF-8608155- | (NATO Advanced workshop on plant hormone receptors, Bonn, F.R. Germany, 18-22 Aug 1986) | | | |
| 1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87003222 | MN -48 | 12:21142 |
| CONF-8608157- | (Advanced study institute on molten salt chemistry, Camerino, Italy, 3-15 Aug 1986) | | | |
| 1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87004946 | MN -4 | 12:20745 |
| 2 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87004948 | MN -4 | 12:21772 |
| CONF-860911- | (192. American Chemical Society national meeting, Anaheim, CA, USA, 7-12 Sep 1986) | | | |
| | Am. Chem. Soc., Div. Pet. Chem., Gen. Pap., Prepr., 31: No. 3, 827-833(Sep 1986) | | | 12:19987 |
| | Am. Chem. Soc., Div. Pet. Chem., Gen. Pap., Prepr., 31: No. 3, 818-825(Sep 1986) | | | 12:19988 |
| | Am. Chem. Soc., Div. Pet. Chem., Gen. Pap., Prepr., 31: No. 3, 699(Sep 1986) | | | 12:19989 |
| | Am. Chem. Soc., Div. Pet. Chem., Gen. Pap., Prepr., 31: No. 3, 817(Sep 1986) | | | 12:20779 |
| | Am. Chem. Soc., Div. Pet. Chem., Gen. Pap., Prepr., 31: No. 3, 791-797(Sep 1986) | | | 12:20780 |

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| | Am. Chem. Soc., Div. Pet. Chem., Gen. Pap., Prepr., 31: No. 3, 798-802(Sep 1986) | | | 12:20781 |
| | Am. Chem. Soc., Div. Pet. Chem., Gen. Pap., Prepr., 31: No. 3, 751(Sep 1986) | | | 12:21098 |
| | Am. Chem. Soc., Div. Pet. Chem., Gen. Pap., Prepr., 31: No. 3, 751(Sep 1986) | | | 12:21099 |
| 25 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87004402 | MN -4 | 12:20724 |
| CONF-860917- | (14. SOFT - symposium on fusion technology, Avignon, France, 8-12 Sep 1986) | | | |
| 14 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87004668 | MN -20d | 12:21960 |
| 15 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87004717 | MN -20d | 12:20532 |
| CONF-860918- | (7. international conference on hyperfine interactions, Bangalore, India, 8-12 Sep 1986) | | | |
| | *See* HMI-P-86/7-HF-Prepr. | DE87751286 | MN -34C | 12:21656 |
| CONF-860939- | (13. world conference of the Nuclear Target Development Society, Chalk River, Canada, 17-19 Sep 1986) | | | |
| 3 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87004681 | MN -38 | 12:20814 |
| CONF-860961- | (Instrumentation, components and materials contractors' meeting, Morgantown, WV, USA, 16-17 Sep 1986) | | | |
| | *See* DOE/METC-86/6069 | E 1.99: DE86006596 | MN -90h | 12:21021 |
| CONF-8609127- | (SPIE's fiber LASE '86, Cambridge, MA, USA, 14-26 Sep 1986) | | | |
| 18 | *See* DOE/DP/40200-45 | E 1.99: DE87005921 | MN -21 | 12:21974 |
| CONF-8609157- | (International workshop on the properties of ceramics and their measurements, Soverato, Italy, 22-27 Sep 1986) | | | |
| 2 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87004663 | MN -20c | 12:21965 |
| CONF-8609159- | (International school-seminar on heavy ion physics, Dubna, USSR, 23-30 Sep 1986) | | | |
| 5-Prepr. | *See* GSI-86-41-Prepr. | DE87751269 | MN -34C | 12:21666 |
| CONF-8609173- | (2. conference on hypercube multiprocessors, Knoxville, TN, USA, 29-30 Sep 1986) | | | |
| 8 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87003658 | MN -38 | 12:20819 |
| CONF-8609218- | (6. international conference on non destructive testing methods, Biarritz, France, 30 Sep-3 Oct 1986) | | | |
| 1 | *See* CEA-CONF-8561 | DE87751023 | MN -25 | 12:20914 |
| 2 | *See* CEA-CONF-8582 | DE87751041 | MN -85 | 12:20915 |
| CONF-8609234- | (International collaboration on advanced neutron sources, Villigen, Switzerland, 22-26 Sep 1986) | | | |
| 6 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87004650 | MN -34C | 12:20975 |
| CONF-8609235- | (International conference on solar neutrino detection with /sup 205/T1 and related topics, Dubrovnik, Yugoslavia, 29 Sep-3 Oct 1986) | | | |
| 1 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87004655 | MN -34C | 12:21663 |
| CONF-8609238- | (2. international laser science conference, Seattle, WA, USA, 20-24 Sep 1986) | | | |
| 1 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87004670 | MN -38 | 12:20725 |
| CONF-8609239- | (Electrophoresis '86: 5th meeting of the International Electrophoresis Society, London, UK, 9-12 Sep 1986) | | | |
| 1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87004648 | MN -48 | 12:21143 |
| CONF-8609242- | (Robots west conference, Long Beach, CA, USA, 22-25 Sep 1986) | | | |
| 1 | *See* HEDL-SA-3449-FP | E 1.99: DE87005485 | MN -38 | 12:20831 |
| CONF-8609246- | (Benguela '86, Cape Town, South Africa, 8-12 Sep 1986) | | | |
| 1 | *See* BNL-38988 | E 1.99: DE87003470 | MN -11 | 12:21128 |
| CONF-8609252- | (Conference on the physics of multiple charged ions, Groningen, Netherlands, 17-19 Sep 1986) | | | |
| 1 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: DE87005778 | MN -34A | 12:21719 |
| CONF-8609254- | (ISQM Tokyo '86, Tokyo, Japan, 1-4 Sep 1986) | | | |
| 1 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87004666 | MN -34C | 12:21773 |
| CONF-8609258- | (Congress of the Societe Francaise de Chimie, Paris, France, 8-12 Sep 1986) | | | |
| 1 | *See* CEA-CONF-8693 | DE87751681 | MN -11 | 12:21059 |
| CONF-861007- | (Nuclear science and nuclear power systems symposium, Washington, DC, USA, 29-31 Oct 1986) | | | |
| 24 | *See* FNAL-TM-1427 | E 1.99: DE87004228 | STD -32 | 12:22059 |
| 25 | *See* KMSF-U-1821 | DE87003424 | MN -21 | 12:22006 |
| CONF-861038- | (OSA/APS international laser science conference, Seattle, WA, USA, 20-24 Oct 1986) | | | |
| 4 | *See* LA-UR-86-4135 | E 1.99: DE87003723 | MN -4 | 12:20747 |
| 7 | *See* KMSF-U-1824 | E 1.99: DE87003425 | MN -21 | 12:22007 |
| CONF-861041- | (Society of Automotive Engineers international fuels and lubricants meeting and technical display, Philadelphia, PA, USA, 6-9 Oct 1986) | | | |
| | Society of Auto Engineers, 400 Commonwealth Dr., Warrendale, PA 15096 | | | 12:20167 |
| | Society of Auto Engineers, 400 Commonwealth Dr., Warrendale, PA 15096 | | | 12:20168 |
| | Society of Auto Engineers, 400 Commonwealth Dr., Warrendale, PA 15096 | | | 12:20518 |

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|---|---|---|---|---|---|
| | Society of Auto Engineers, 400 Commonwealth Dr., Warrendale, PA 15096 | | | | 12:20519 |
| CONF-861077- | (Workshop on nuclear structure at moderate and high spin, Berkeley, CA, USA, 13-16 Oct 1986) | | | | |
| Vugraphs | *See* LBL-22379 | | DE87003622 | MN -34C | 12:21626 |
| CONF-8610115- | (4. international symposium on the production and neutralization of negative ions and beams, Upton, NY, USA, 27-31 Oct 1986) | | | | |
| 22 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005683 | MN -20a | 12:21966 |
| CONF-8610135- | (14. water reactor safety information meeting, Gaithersburg, MD, USA, 27-31 Oct 1986) | | | | |
| 60 | *See* SAND-86-2500C | E 1.99: | DE87002057 | MN -78 | 12:20437 |
| Vol.1 | *See* NUREG/CP-0082-Vol.1 | | TI87005722 | MN -78 | 12:20433 |
| Vol.2 | *See* NUREG/CP-0082-Vol.2 | | TI87005805 | MN -78 | 12:20434 |
| Vol.3 | *See* NUREG/CP-0082-Vol.3 | | TI87005959 | MN -78 | 12:20435 |
| Vol.6 | *See* NUREG/CP-0082-Vol.6 | | TI87005860 | MN -78 | 12:20436 |
| CONF-8610193- | (International colloquia on methodologies for intelligent systems, Knoxville, TN, USA, 25 Oct 1986) | | | | |
| | *See* ORNL-6362 | E 1.99: | DE87006025 | MN -32 | 12:22071 |
| CONF-8610206- | (Impro '86: conference on quality improvement, Chicago, IL, USA, 9-10 Oct 1986) | | | | |
| 1 | Juran Institute, Inc., 88 Danbur Road, Wilton, CT 0687-4409 | | TI87004074 | ND -38 | 12:20820 |
| CONF-8610214- | (International symposium on fusion reactor blanket and fuel cycle technology, Tokai-mura, Japan, 27-29 Oct 1986) | | | | |
| 1 | *See* LA-UR-86-3556 | | DE87001964 | MN -20d | 12:22008 |
| 2 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87004936 | MN -20d | 12:21967 |
| 4 | NTIS, PC A02; 3 | | DE87004957 | MN -20d | 12:21968 |
| CONF-8610220- | (DOE contractors meeting, Pittsburgh, PA, USA, 21-22 Oct 1986) | | | | |
| 3 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87004854 | MN -90 | 12:19957 |
| CONF-8610226- | (6. annual plutonium pyrochemical workshop, Los Alamos, NM, USA, 7-8 Oct 1986) | | | | |
| 5 | *See* DP-MS-86-168 | E 1.99: | DE87006381 | MN -86 | 12:20104 |
| CONF-8610233- | (1. Huntsville workshop on magnetosphere/ionosphere plasma models, Guntersville, AL, USA, 13-16 Oct 1986) | | | | |
| 1 | *See* LA-UR-87-183 | E 1.99: | DE87005101 | MN -34B | 12:21412 |
| CONF-8610240- | (IUTAM conference: electromagnetomechanical interactions in deformable solids and structures, Tokyo, Japan, 12-17 Oct 1986) | | | | |
| 1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87004938 | MN -20a | 12:21969 |
| CONF-8610251- | (Kal Kan symposium on veterinary oncology, Columbus, OH, USA, 10-13 Oct 1986) | | | | |
| 1 | *See* PNL-SA-14707 | E 1.99: | DE87006401 | MN -48 | 12:21190 |
| 2 | *See* PNL-SA-14361 | E 1.99: | DE87006403 | MN -48 | 12:21189 |
| CONF-861102- | (American Nuclear Society and Atomic Industrial Forum joint meeting, Washington, DC, USA, 16-21 Nov 1986) | | | | |
| 39 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87004741 | MN -79 | 12:20417 |
| 40 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87004747 | MN -34C | 12:21704 |
| CONF-861106- | (IAEA international conference on plasma physics and controlled nuclear fusion research, Kyoto, Japan, 12-19 Nov 1986) | | | | |
| 16 | *See* GA-A-18596 | E 1.99: | DE87005383 | MN -20f | 12:21863 |
| 18 | *See* IAEA-CN-47/A-III-4 | E 1.99: | DE87005717 | MN -20a | 12:21870 |
| 21 | *See* DOE/DP/40200-31 | E 1.99: | DE87005916 | MN -21 | 12:21972 |
| CONF-861110- | (American Physical Society Plasma Physics Division meeting, Baltimore, MD, USA, 3-7 Nov 1986) | | | | |
| 6-Vugraphs | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006116 | MN -34 | 12:21421 |
| CONF-861114- | (9. international conference on application of accelerators in research and industry, Denton, TX, USA, 10-12 Nov 1986) | | | | |
| 54 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005808 | MN -34A | 12:21422 |
| CONF-861132- | (10. symposium on flue gas desulfurization, Atlanta, GA, USA, 18-21 Nov 1986) | | | | |
| 2 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87004687 | MN -90i | 12:19917 |
| CONF-861146- | (AIChE winter annual meeting, Miami, FL, USA, 2-7 Nov 1986) | | | | |
| 13 | *See* PNL-SA-13708 | E 1.99: | DE87003307 | MN -4 | 12:20785 |
| CONF-861175- | (IAEA workshop on the stellerator heliotron, Kyoto, Japan, 25-28 Nov 1986) | | | | |
| 1 | NTIS, PC A03; 3 | | DE87005505 | MN -20 | 12:21961 |
| 3-Vugraphs | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005506 | MN -20 | 12:21962 |
| 4-Vugraphs | NTIS, PC A02; 3 | | DE87005690 | MN -20b | 12:21963 |
| CONF-861177- | (9. international conference on lasers and applications, Orlando, FL, USA, 3-7 Nov 1986) | | | | |
| 8 | *See* UCRL-95845 | | DE87005815 | MN -38 | 12:20967 |
| CONF-8611110- | (SEM fall meeting, Keystone, CO, USA, 2-5 Nov 1986) | | | | |
| 2 | *See* EGG-M-32586 | | DE87001444 | MN -38 | 12:20917 |

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|---|---|---|---|---|
| CONF-8611115- | (Nuclear explosives code development conference, Albuquerque, NM, USA, 17-20 Nov 1986) | | | |
| 1 | *See* SAND-86-2300C | E 1.99: DE87003504 | MN -34D | 12:21709 |
| CONF-8611124- | (3. international workshop on cross sections for fusion and other applications, College Station, TX, USA, 6-8 Nov 1986) | | | |
| 1 | *See* LBL-22457 | E 1.99: DE87003540 | MN -20 | 12:21923 |
| 2 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87005685 | MN -34C | 12:21423 |
| CONF-8611126- | (15. international finite element congress, Baden-Baden, F.R. Germany, 17-18 Nov 1986) | | | |
| 1 | *See* UCRL-95152 | E 1.99: DE87003818 | MN -38 | 12:20836 |
| CONF-8611127- | (UHV gauging workshop, Gaithersburg, MD, USA, 3-4 Nov 1986) | | | |
| 1 | *See* BNL-38825 | E 1.99: DE87002390 | MN -28 | 12:21020 |
| CONF-8611132- | (WESCON '86, Anaheim, CA, USA, 18 Nov 1986, 18 Nov 1986) | | | |
| 1 | *See* HEDL-SA-3577-FP | E 1.99: DE87005462 | MN -38 | 12:20929 |
| CONF-8611137- | (International congress on applications of lasers and electro optics, Washington, DC, USA, 1 Nov 1986,- 10 Aug 1822) | | | |
| 1 | *See* K/TS-11811 | E 1.99: DE87005960 | MN -34 | 12:20809 |
| CONF-8611139- | (Remote handling operations in waste processing, decontamination, and size-reduction facilities conference, Washington, DC, USA, 12-17 Nov 1986) | | | |
| 1 | *See* DP-MS-86-71 | E 1.99: DE87006382 | MN -70 | 12:20101 |
| CONF-8611140- | (4. conference on rapid solidification processing, Santa Barbara, CA, USA, 14-18 Nov 1986) | | | |
| 1 | *See* UCRL-95452 | E 1.99: DE87006239 | MN -34 | 12:21802 |
| CONF-861204- | (4. Miami international symposium on multi-phase transport and particulate phenomena, Miami Beach, FL, USA, 15-17 Dec 1986) | | | |
| 6 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: DE87004705 | MN -78 | 12:20418 |
| CONF-861207- | (Materials Research Society fall meeting, Boston, MA, USA, 1-5 Dec 1986) | | | |
| 67 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87005696 | MN -25 | 12:20533 |
| 78 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87006612 | MN -25 | 12:20916 |
| CONF-861220- | (American Geophysical Union fall meeting, San Francisco, CA, USA, 8-12 Dec 1986) | | | |
| 2 | *See* SAND-86-1679C | E 1.99: DE87003041 | MN -4 | 12:20129 |
| CONF-861250- | (IAEA advisory group meeting on nuclear data for fusion reactor technology, Dresden, German D.R., 1-5 Dec 1986) | | | |
| 2 | *See* LA-UR-87-219 | E 1.99: DE87005098 | MN -34C | 12:21625 |
| CONF-861253- | (International tokamak reactor workshop, Vienna, Austria, 1-13 Dec 1986) | | | |
| 1 | *See* UCRL-95759 | E 1.99: DE87003819 | MN -20b | 12:22015 |
| CONF-861254- | (International workshop for eddy current code comparison, Tokyo, Japan, 20-21 Dec 1986) | | | |
| 1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87004709 | MN -20 | 12:21964 |
| CONF-861256- | (Topical conference on the physics of radiatively driven ICF targets, Albuquerque, NM, USA, 8-11 Dec 1986) | | | |
| 1 | *See* SAND-87-0191C | E 1.99: DE87005531 | MN -21 | 12:22010 |
| CONF-861258- | (9. international thermal expansion symposium, Pittsburgh, PA, USA, 8-10 Dec 1986) | | | |
| 1 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87004273 | MN -20c | 12:20629 |
| CONF-861260- | (ARFTG conference digest conference, St. Petersburg, FL, USA, 4 Dec 1986, 4 Dec 1986) | | | |
| 1 | *See* BDX-613-3628 | E 1.99: DE87005051 | MN -38 | 12:20813 |
| CONF-861264- | (Texas symposium, Chicago, IL, USA, 14-19 Dec 1986) | | | |
| 1 | *See* LA-UR-87-358 | E 1.99: DE87006051 | MN -34B | 12:21299 |
| CONF-870102- | (4. symposium on space nuclear power systems, Albuquerque, NM, USA, 12-16 Jan 1987) | | | |
| 11 | *See* N-87-14422 | | | 12:20370 |
| CONF-870114- | (IEEE/OSA topical meeting on picosecond electronics and optoelectronics, Lake Tahoe, NV, USA, 14-16 Jan 1987) | | | |
| 3 | *See* UCRL-95276 | E 1.99: DE87005073 | MN -38 | 12:20930 |
| CONF-870132- | (LASE-13: pulse power for lasers conference, Los Angeles, CA, USA, 11-16 Jan 1987) | | | |
| 2 | *See* PNL-SA-14140 | E 1.99: DE87003404 | MN -4 | 12:20735 |
| 3 | *See* SAND-86-2926C | E 1.99: DE87004523 | MN -21 | 12:20856 |
| CONF-870133- | (25. AIAA aerospace sciences meeting, Reno, NV, USA, 12-15 Jan 1987) | | | |
| 2 | *See* SAND-86-1403C | E 1.99: DE87004520 | MN -38 | 12:20905 |
| 4 | *See* N-87-14427 | | | 12:20512 |
| CONF-870134- | (Workshop on space telerobotics, Pasadena, CA, USA, 20-22 Jan 1987) | | | |
| 2 | NTIS, PC A02; 3 | DE87005719 | MN -38 | 12:20815 |
| CONF-870136- | (12. workshop on geothermal reservoir engineering, Stanford, CA, USA, 20-22 Jan 1987) | | | |
| 5 | *See* LBL-22810 | DE87006043 | MN -66a | 12:20292 |

| Report Number | Availability Source | File Number | Distribution Category | Abstract Number |
|---|---|---|---|---|
| CONF-870145- | (Standards development for ground water monitoring meeting, Tampa, FL, USA, 20-23 Jan 1987) | | | |
| 1 | *See* PNL-SA-14527 | E 1.99: DE87004917 | MN -11 | 12:21134 |
| CONF-870150- | (Long Island University computer technology symposium, Brookville, NY, USA, 23 Jan 1987, 23 Jan 1987) | | | |
| 1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87005192 | MN -32 | 12:22058 |
| CONF-870157- | (Relativistic astrophysics conference, Pasadena, CA, USA, 4-8 Jan 1987) | | | |
| 1 | *See* LA-UR-87-409 | E 1.99: DE87006054 | MN -34B | 12:21300 |
| CONF-870203- | (Institute of Electrical and Electronic Engineers/ Power Engineering Society winter meeting, New Orleans, LA, USA, 1-6 Feb 1987) | | | |
| 2 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87004078 | MN -97 | 12:20320 |
| CONF-870219- | (Midyear topical symposium of the Health Physics Society: health physics of radiation-producing machines, Reno, NV, USA, 8-12 Feb 1987) | | | |
| 10 | *See* UCRL-94044 | E 1.99: DE87003814 | MN -41 | 12:22014 |
| CONF-870246- | (International Peat Society symposium on tropical peat and peatlands for development, Yoguakurta, Indonesia, 9-14 Feb 1987) | | | |
| 1 | *See* LA-UR-86-4382 | E 1.99: DE87003762 | MN -90 | 12:19927 |
| CONF-870247- | (International Rosenbluth symposium on dynamics of particles and plasmas, Austin, TX, USA, 2-5 Feb 1987) | | | |
| 1 | *See* UCRL-95992 | E 1.99: DE87005057 | MN -20 | 12:21931 |
| CONF-870249- | (Computing high energy physics, Pacific Grove, CA, USA, 2-6 Feb 1987) | | | |
| 1 | *See* SLAC-PUB-4148 | E 1.99: DE87004558 | MN -32 | 12:22074 |
| CONF-870252- | (Solving ground water problems with models conference, Denver, CO, USA, 10-12 Feb 1987) | | | |
| 4 | *See* SAND-87-0068C | E 1.99: DE87005876 | MN -70 | 12:20131 |
| 6 | *See* LBL-22794 | E 1.99: DE87006143 | MN -11 | 12:21263 |
| CONF-870254- | (3. international conference on ultrastructure processing of ceramics, glasses, and composites, San Diego, CA, USA, 23-27 Feb 1987) | | | |
| 2 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87005721 | MN -4 | 12:20630 |
| CONF-870301- | (International topical meeting on remote systems and robotics in hostile environments, Pasco, WA, USA, 29 Mar-2 Apr 1987) | | | |
| 3 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87002818 | MN -38 | 12:20816 |
| 8 | *See* DP-MS-86-134 | E 1.99: DE87003114 | MN -38 | 12:20822 |
| 14 | NTIS, PC A02; 3 | DE87004076 | MN -38 | 12:20817 |
| CONF-870306- | (Waste management '87, Tucson, AZ, USA, 1-5 Mar 1987) | | | |
| 27 | *See* DP-MS-86-142 | E 1.99: DE87006388 | MN -70 | 12:20103 |
| 28 | *See* DP-MS-86-110 | E 1.99: DE87006386 | MN -70B | 12:20102 |
| 29 | *See* PNL-SA-14279 | E 1.99: DE87006436 | MN -70 | 12:20127 |
| 30 | *See* PNL-SA-14216 | E 1.99: DE87006435 | MN -70 | 12:20126 |
| 32 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87006614 | MN -70 | 12:20061 |
| 33 | *See* PNL-SA-14350 | DE87006431 | MN -85 | 12:20056 |
| 36 | *See* PNL-SA-14615 | E 1.99: DE87006432 | MN -71 | 12:20140 |
| 41 | *See* SAND-86-2222C | E 1.99: DE87006900 | MN -71 | 12:20057 |
| CONF-870307- | (ASME/JSME/ISES solar energy conference, Honolulu, HI, USA, 22-27 Mar 1987) | | | |
| 8 | *See* DOE/NASA/33408-1 | E 1.99: DE87004216 | STD -38 | 12:20247 |
| 15 | *See* SAND-86-1978C | DE87005067 | MN -62 | 12:20280 |
| 17 | *See* SERI/TP-252-2976 | E 1.99: DE87001119 | MN -62a | 12:20249 |
| CONF-870314- | (Corrosion '87, San Francisco, CA, USA, 9-13 Mar 1987) | | | |
| 3 | *See* DP-MS-86-66 | E 1.99: DE87002649 | MN -38 | 12:20821 |
| 9 | *See* PNL-SA-14370 | E 1.99: DE87006405 | MN -25 | 12:20553 |
| CONF-870323- | (American Institute of Chemical Engineers spring national meeting, Houston, TX, USA, 29 Mar-2 Apr 1987) | | | |
| 2 | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: DE87005396 | MN -90i | 12:21061 |
| CONF-870354- | (IEEE international conference on robotics and automation, Raleigh, NC, USA, 30 Mar-2 Apr 1987) | | | |
| 3 | NTIS, PC A02; 3 | DE87005718 | MN -38 | 12:20818 |
| CONF-870359- | (5. seminar on magnetohydrodynamic flows and turbulance, Jerusalem, Israel, 2-6 Mar 1987) | | | |
| 1 | *See* LA-UR-87-519 | E 1.99: DE87006058 | MN -34 | 12:21799 |
| CONF-870370- | (IEEE IMTC '87: the changing face of I and M technologies, Boston, MA, USA, 27-29 Mar 1987) | | | |
| 1 | *See* SAND-86-1698C | E 1.99: DE87003036 | MN -38 | 12:21038 |
| CONF-870377- | (International congress on recent advances in the management of hazardous and toxic wastes in the process industries, Vienna, Austria, 8-13 Mar 1987) | | | |
| 1 | *See* Y/DZ-234 | E 1.99: DE87005914 | MN -11 | 12:21137 |
| CONF-870379- | (ASP-ACSM annual spring meeting, Washington, DC, USA, 26 Mar-3 Apr 1987) | | | |
| 1 | *See* SLAC-PUB-4141 | E 1.99: DE87004566 | MN -28 | 12:20965 |

| Report Number | Availability Source | File Number | Distribution Category | Abstract Number |
|---|---|---|---|---|
| CONF-870380- | (American Society of Photogrammetric Engineering and Remote Sensing, Baltimore, MD, USA, 22-27 Mar 1987) | | | |
| 1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87005711 | MN -11 | 12:21112 |
| CONF-870381- | (Symposium on safeguards at Los Alamos: 20 years, Los Alamos, NM, USA, 5-6 Mar 1987) | | | |
| 1 | *See* RFP-4091 | E 1.99: DE87005657 | MN -15 | 12:20146 |
| CONF-870401- | (OSA/IEEE conference on lasers and electro-optics (CLEO '87), Baltimore, MD, USA, 27 Apr-1 May 1987) | | | |
| 2 | *See* LA-UR-86-3916 | E 1.99: DE87003711 | MN -28 | 12:20945 |
| CONF-870405- | (Radiation protection and shielding conference, Knoxville, TN, USA, 22-24 Apr 1987) | | | |
| 9 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87005511 | MN -85 | 12:20049 |
| 12 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87004068 | MN -41 | 12:21202 |
| 13 | *See* UCRL-95789 | E 1.99: DE87003465 | MN -41 | 12:21205 |
| CONF-870410- | (193. national meeting of the American Chemical Society, Denver, CO, USA, 5-10 Apr 1987) | | | |
| 1 | *See* DOE/PC/70796-11 | E 1.99: DE87002299 | MN -90a | 12:19914 |
| 4 | *See* SAND-86-2471C | E 1.99: DE87002488 | MN -34A | 12:21753 |
| 4 | *See* SAND-86-2471C | E 1.99: DE87002488 | MN -34A | 12:21753 |
| CONF-870414- | (12. world petroleum congress, Houston, TX, USA, 26 Apr-1 May 1987) | | | |
| 1 | *See* UCRL-95580 | E 1.99: DE87002383 | MN -11 | 12:21094 |
| CONF-870416- | (14. annual energy technology conference and exposition, Washington, DC, USA, 14-16 Apr 1987) | | | |
| 2 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87005694 | MN -11 | 12:21062 |
| 4 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87006206 | MN -95d | 12:20483 |
| CONF-870424- | (American Nuclear Society international meeting on advances in reactor physics, mathematics and computation, Paris, France, 27-30 Apr 1987) | | | |
| 3 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87004399 | MN -32 | 12:21771 |
| 6 | *See* LA-UR-87-140 | E 1.99: DE87005106 | MN -34 | 12:22068 |
| CONF-870435- | (Energy '87: energy solutions today for the nineties, Atlantic City, NJ, USA, 27-30 Apr 1987) | | | |
| 2 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87000393 | MN -41 | 12:21228 |
| CONF-870466- | (International conference on environmental degradation of engineering materials, University Park, PA, USA, 13-15 Apr 1987) | | | |
| 2 | *See* SAND-86-2448C | E 1.99: DE87005877 | MN -20c | 12:20638 |
| CONF-870468- | (Reliability '87, Birmingham, UK, 14-16 Apr 1987) | | | |
| 1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87004613 | MN -79 | 12:20361 |
| CONF-870469- | (CEF 87: the use of computers in chemical engineering, Taormina, Sicily, Italy, 26-30 Apr 1987) | | | |
| 1 | *See* LBL-22470 | E 1.99: DE87004474 | MN -38 | 12:21801 |
| CONF-870470- | (IEEE conference on acoustics, speech and signal processing, Dallas, TX, USA, 6-9 Apr 1987) | | | |
| 1 | *See* UCRL-95351 | E 1.99: DE87003464 | MN -38 | 12:21048 |
| CONF-870471- | (DECUS spring meeting, Nashville, TN, USA, 27 Apr-1 May 1987) | | | |
| 1 | *See* LA-UR-86-4336 | E 1.99: DE87003754 | MN -32 | 12:22067 |
| CONF-870473- | (AGARD fluid dynamics panel symposium, Bristol, UK, 6-9 Apr 1987) | | | |
| 1 | *See* SAND-86-2960C | DE87004526 | MN -38 | 12:20906 |
| CONF-870478- | (Southeastcon '87, Tampa, FL, USA, 5-8 Apr 1987) | | | |
| 1 | *See* Y/CSD/INF-86/28 | E 1.99: DE87004015 | MN -38 | 12:20921 |
| CONF-870479- | (AIAA/ASME structural dynamics and materials conference, Monterey, CA, USA, 6-8 Apr 1987) | | | |
| 1 | *See* SAND-86-1935C | E 1.99: DE87005537 | MN -38 | 12:20810 |
| CONF-870483- | (Santa Barbara workshop on solar neutrinos, Santa Barbara, CA, USA, 29 Apr-2 May 1987) | | | |
| 1 | *See* LA-UR-87-285 | E 1.99: DE87006075 | MN -34B | 12:21298 |
| CONF-870485- | (Ion-Ex '87, Wrexham, UK, 13-16 Apr 1987) | | | |
| 1 | *See* DP-MS-86-187 | E 1.99: DE87006380 | MN -70 | 12:20105 |
| CPL-598-2 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87006177 | MN -66a | 12:20294 |
| CPT-0057 | *See* CONF-8603115-4 | E 1.99: DE87004491 | MN -34D | 12:21662 |
| CRC-548 | *See* AD-A-175363/1/XAB | | | 12:19977 |
| CRM-84-29 | *See* AD-A-175532/1/XAB | | | 12:20526 |
| CRN-HE-84-04 | NTIS (US Sales Only), PC A10/MF A01 | DE87750987 | MN -34D | 12:21494 |
| CSIR-RR-597 | NTIS (US Sales Only), PC A02/MF A01 | DE87700852 | MN -4 | 12:20801 |
| CTA-IEAV-NT-07/85 | NTIS (US Sales Only), PC A02/MF A01 | DE87700853 | MN -80 | 12:20374 |
| DFVLR-FB-86-51 | NTIS (US Sales Only), PC A08/MF A01; 1 | DE87751617 | MN -11 | 12:21052 |
| DHHS/PUB/NIOSH-86-123 | *See* PB-87-133674/XAB | | | 12:21201 |
| DOE/AL/33218-T7 | NTIS, PC A09; 3 | DE87004856 | MN -71 | 12:20050 |

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|---|---|---|---|---|---|
| DOE/BC/10852-1 | NTIS, PC A16/MF A01; 1 | | DE87001216 | MN -92 | 12:19970 |
| DOE/BP/15102-1 | NTIS, PC A08/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006020 | MN -95d | 12:20484 |
| DOE/BP/18690-4 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005935 | MN -98G | 12:21110 |
| DOE/BP/23462-1 | NTIS, PC A05/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006184 | MN -95f | 12:20499 |
| DOE/BP/23462-2 | NTIS, PC A03/MF A01; 1 | | DE87006182 | MN -95f | 12:20500 |
| DOE/CH-10140-05(86) | NTIS, PC A16/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006597 | STD -70 | 12:20075 |
| DOE/CH/10093-H2 | NTIS, PC A14/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006582 | STD -63 | 12:20179 |
| DOE/CH/10140-06 | NTIS, PC A15/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006730 | STD -70 | 12:20076 |
| DOE/DP/40200-24-Vol.26 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005865 | MN -21 | 12:21970 |
| 30 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: | DE87005915 | MN -21 | 12:21971 |
| 31 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005916 | MN -21 | 12:21972 |
| 32 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005917 | MN -21 | 12:21973 |
| 45 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005921 | MN -21 | 12:21974 |
| DOE/DP/40211-1 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005040 | MN -21 | 12:21975 |
| DOE/EI/19722-T1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005435 | MN -98B | 12:19979 |
| DOE/EI/19723-T1 | NTIS, PC A02; 3 | | DE87005436 | MN -98B | 12:19980 |
| DOE/EI/19724-T1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005434 | MN -98B | 12:19981 |
| DOE/EIA-0035(86/ 11) | NTIS, PC A07 - GPO; 3 | | DE87006355 | MN -98 | 12:19982 |
| 0109(86/ 12) | NTIS, PC A06/MF A01 - GPO (GPO Dep.) | E 1.99: | DE87006005 | MN -98B | 12:19983 |
| 0130(86/ 12) | NTIS, PC A08 - GPO; 3 | | DE87006417 | MN -98C | 12:19993 |
| 0437(85) | NTIS, PC A99/MF A01 - GPO; 1 (GPO Dep.) | E 1.99: | DE87006836 | MN -98E | 12:20471 |
| M018 | NTIS MF A01- GPO; 2 (GPO Dep.) | E 1.99: | DE87006754 | MN -98 | 12:20470 |
| DOE/EIS-0117D | NTIS, PC A21/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006155 | MN -70A | 12:20137 |
| DOE/ER-0311 | NTIS, PC A09/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006593 | MN -34C | 12:21620 |
| 0314 | NTIS, PC A06/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006596 | STD -25 | 12:20631 |
| DOE/ER/10405-T12 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87000341 | MN -34C | 12:21664 |
| DOE/ER/10637-T4 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006649 | MN -48 | 12:21144 |
| T5 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006650 | MN -48 | 12:21145 |
| DOE/ER/13081-T1 | NTIS, PC A07/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006003 | MN -38 | 12:20891 |
| T2 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006002 | MN -38 | 12:20892 |
| DOE/ER/13093-T1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005432 | MN -34A | 12:21424 |
| DOE/ER/13116-9 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005660 | MN -34A | 12:21425 |
| DOE/ER/13123-3 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006663 | MN -34 | 12:21774 |
| DOE/ER/13178-3 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006917 | MN -34 | 12:21775 |
| DOE/ER/13187-3 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006267 | MN -48 | 12:20180 |
| DOE/ER/13228-T1 | NTIS, PC A05/MF/A01; 1 (GPO Dep.) | E 1.99: | DE87006337 | MN -11 | 12:21279 |
| DOE/ER/13322-T1 | NTIS, PC A05/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005992 | MN -11 | 12:21280 |
| DOE/ER/13377-2 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87006031 | MN -48 | 12:21153 |
| DOE/ER/13472-1 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005553 | MN -34 | 12:21268 |
| DOE/ER/13473-2 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87006364 | MN -25 | 12:20534 |
| DOE/ER/13489-1 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87004792 | MN -38 | 12:20893 |
| DOE/ER/13553-1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006255 | MN -38 | 12:20894 |
| DOE/ER/13560-1 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87006292 | MN -25 | 12:20535 |
| DOE/ER/40200-088 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006234 | MN -34D | 12:21563 |
| DOE/ER/40272-18 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005676 | MN -34D | 12:21524 |
| 24 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005678 | MN -34D | 12:21525 |
| 28 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: | DE87005680 | MN -34D | 12:21526 |
| DOE/ER/45102-T1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006294 | MN -25 | 12:20656 |
| DOE/ER/51030-T2 | NTIS, PC A08/MF A01; 1 (GPO Dep.) | E 1.99: | DE87004602 | MN -20b | 12:21839 |

| Report Number | Availability Source | File Number | Distribution Category | Abstract Number |
|---|---|---|---|---|
| DOE/ER/53122-3 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87006407 | MN -20 | 12:21840 |
| DOE/ER/53167-1 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: DE87005704 | MN -34A | 12:21720 |
| DOE/ER/53201-T1 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87004900 | STD -20g | 12:21841 |
| DOE/ER/53206-7 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87006335 | MN -20a | 12:21842 |
| DOE/ER/53219-1 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87005438 | MN -20 | 12:21843 |
| DOE/ER/60172-2 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: DE87005705 | MN -11 | 12:21136 |
| DOE/ER/60179-3 | NTIS, PC A03; 3 | DE87005515 | MN -11 | 12:21119 |
| DOE/ER/60277-T1 | NTIS, PC A06/MF A01; 1 (GPO Dep.) | E 1.99: DE87005034 | MN -11 | 12:21113 |
| DOE/ER/60350-2 | NTIS, PC A02; 3 | DE87006362 | MN -11 | 12:21063 |
| DOE/ER/60355-1 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87005307 | MN -11 | 12:21289 |
| DOE/ER/60432-2 | Air Pollution Control Assoc., P.O. Box 2861, Pittsburgh, PA 15230; 3 | TI87004492 | ND -69 | 12:21105 |
| DOE/ET/53047-25 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: DE87005554 | MN -20a | 12:21844 |
| DOE/ET/53088-264 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87005522 | MN -20f | 12:21845 |
| 269 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87006344 | MN -20g | 12:21846 |
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| **FRADOC-** | | | | |
| 7-7 | NTIS (US Sales Only), PC A02/MF A01 | DE87750992 | MN -78 | 12:20333 |
| 8-3 | NTIS (US Sales Only), PC A02/MF A01 | DE87750993 | MN -78 | 12:20538 |
| 8-4 | NTIS (US Sales Only), PC A03/MF A01 | DE87750994 | MN -78 | 12:20334 |
| 8-5 | NTIS (US Sales Only), PC A02/MF A01 | DE87750995 | MN -78 | 12:20335 |

| Report Number | Availability Source | File Number | | Distribution Category | Abstract Number |
|---|---|---|---|---|---|
| 8-6 | NTIS (US Sales Only), PC A03/MF A01 | | DE87750996 | MN -78 | 12:20336 |
| 8-7 | NTIS (US Sales Only), PC A02/MF A01 | | DE87750997 | MN -78 | 12:20337 |
| 8-8 | NTIS (US Sales Only), PC A02/MF A01 | | DE87750998 | MN -78 | 12:20420 |
| 8-9 | NTIS (US Sales Only), PC A02/MF A01 | | DE87750999 | MN -78 | 12:20338 |
| 9-1 | NTIS (US Sales Only), PC A02/MF A01 | | DE87751000 | MN -78 | 12:20339 |
| 9-2 | NTIS (US Sales Only), PC A02/MF A01 | | DE87751001 | MN -78 | 12:20340 |
| 9-3 | NTIS (US Sales Only), PC A02/MF A01 | | DE87751002 | MN -78 | 12:20341 |
| 9-4 | NTIS (US Sales Only), PC A02/MF A01 | | DE87751003 | MN -78 | 12:20342 |
| 9-5 | NTIS (US Sales Only), PC A02/MF A01 | | DE87751004 | MN -78 | 12:20421 |
| 9-6 | NTIS (US Sales Only), PC A02/MF A01 | | DE87751005 | MN -70 | 12:20052 |
| 9-8 | NTIS (US Sales Only), PC A02/MF A01 | | DE87751027 | MN -78 | 12:20343 |
| 9-9 | NTIS (US Sales Only), PC A02/MF A01 | | DE87751026 | MN -78 | 12:20344 |
| 9-10 | NTIS (US Sales Only), PC A03/MF A01 | | DE87751025 | MN -78 | 12:20345 |
| **FRCEA-R-** | | | | | |
| 23 | NTIS (US Sales Only), PC A09/MF A01 | | DE87751056 | MN -34 | 12:21290 |
| **FTD-ID(RS)T-** | | | | | |
| 0995-86 | *See* AD-A-175577/6/XAB | | | | 12:20528 |
| **GA-A-** | | | | | |
| 18418 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005237 | MN -20d | 12:21978 |
| 18596 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005383 | MN -20f | 12:21863 |
| **GANIL-RA-** | | | | | |
| 1985 | NTIS (US Sales Only), PC A03/MF A01 | | DE87751055 | MN -28 | 12:20940 |
| **GESD-** | | | | | |
| 87-04 | *See* DOE/NBM-7005567 | E 1.99: | DE87005567 | MN -70 | 12:20099 |
| **GKSS-** | | | | | |
| 86/ E/ 46 | NTIS (US Sales Only), PC A04/MF A01; 1 | | DE87751616 | MN -25 | 12:20539 |
| 86/ E/ 47 | NTIS (US Sales Only), PC A02/MF A01; 1 | | DE87751618 | MN -64 | 12:20830 |
| **GSF-** | | | | | |
| 2/ 86 | NTIS (US Sales Only), PC A12/MF A01 | | DE87751272 | MN -70 | 12:20108 |
| 31/ 85 | NTIS (US Sales Only), PC A06/MF A01 | | DE87751289 | MN -41 | 12:21159 |
| **GSF-B-** | | | | | |
| 1821 | *See* GSF-31/85 | | DE87751289 | MN -41 | 12:21159 |
| **GSF-T-** | | | | | |
| 228 | *See* GSF-2/86 | | DE87751272 | MN -70 | 12:20108 |
| **GSI-** | | | | | |
| 86-40-Prepr. | NTIS (US Sales Only), PC A02/MF A01 | | DE87751293 | MN -34C | 12:21665 |
| 86-41-Prepr. | NTIS (US Sales Only), PC A02/MF A01 | | DE87751269 | MN -34C | 12:21666 |
| **GTFR-** | | | | | |
| 70 | NTIS, PC A02; 3 | | DE87005315 | MN -20c | 12:21979 |
| **HBC-** | | | | | |
| 85-162 | *See* PB-87-132916/XAB | | | | 12:20464 |
| **HEDL-** | | | | | |
| 7573 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005489 | MN -38 | 12:20935 |
| 7581 | NTIS, PC A02; 3 | | DE87005497 | MN -20c | 12:20540 |
| 7584 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87004069 | MN -20c | 12:20541 |
| 7594 | NTIS, PC A02; 3 | | DE87005468 | MN -20c | 12:20542 |
| 7626 | NTIS, PC A02; 3 | | DE87005488 | MN -20c | 12:20543 |
| 7630 | NTIS, PC A02; 3 | | DE87005492 | MN -20 | 12:20544 |
| 7631 | NTIS, PC A02; 3 | | DE87005490 | MN -20c | 12:20545 |
| 7633 | NTIS, PC A02; 3 | | DE87005496 | MN -20c | 12:20546 |
| **HEDL-SA-** | | | | | |
| 3425-FP | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005460 | MN -20c | 12:20547 |
| 3449-FP | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87005485 | MN -38 | 12:20831 |
| 3495-FP | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: | DE87005472 | MN -20c | 12:20548 |
| 3577-FP | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005462 | MN -38 | 12:20929 |
| **HEDL-TME-** | | | | | |
| 86-13 | NTIS, PC A06/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006603 | STD -20e | 12:21980 |
| **HETA-** | | | | | |
| 84-311-1575 | *See* PB-87-133708/XAB | | | | 12:21093 |
| **HMI-** | | | | | |
| 394 | NTIS (US Sales Only), PC A08/MF A01 | | DE87751282 | MN -34C | 12:21706 |
| **HMI-B-** | | | | | |
| 409 | NTIS (US Sales Only), PC A08/MF A01 | | DE87751285 | MN -2 | 12:20726 |
| 419 | NTIS (US Sales Only), PC A08/MF A01 | | DE87751283 | MN -34C | 12:21707 |
| **HMI-P-** | | | | | |
| 86/ 7-HF-Prepr. | NTIS (US Sales Only), PC A02/MF A01 | | DE87751286 | MN -34C | 12:21656 |
| **IA-** | | | | | |
| 1406 | NTIS (US Sales Only), PC A06/MF A01 | | DE87700873 | MN -37 | 12:20977 |
| 1421 | NTIS (US Sales Only), PC A12/MF A01 | | DE87780103 | MN -34 | 12:21780 |
| **IAE-** | | | | | |
| 1971/ E-3/ R/ B | Power System Computer Centre. Mining and Power System Information Department, Palace of Culture and Science, PL-00-901 Warsaw, Poland | | | ND -32 | 12:22060 |
| 1984/ E-3/ R/ B | Power System Computer Centre, Mining and Power System Information Department, Palace of Culture and Science, PL-00-901 Warsaw, Poland | | | ND -80 | 12:20405 |
| 3954/ 2 | NTIS (US Sales Only), PC A04/MF A01 | | DE87700874 | MN -34A | 12:21732 |
| 3992/ 6 | NTIS (US Sales Only), PC A03/MF A01 | | DE87700875 | MN -34A | 12:21428 |
| 4041/ 12 | NTIS (US Sales Only), PC A02/MF A01 | | DE87700876 | MN -34C | 12:21630 |
| 4048/ 2 | NTIS (US Sales Only), PC A03/MF A01 | | DE87700877 | MN -34C | 12:21667 |
| 4063/ 15 | NTIS (US Sales Only), PC A02/MF A01 | | DE87700878 | MN -37 | 12:20980 |
| 4073/ 9 | NTIS (US Sales Only), PC A02/MF A01 | | DE87700879 | MN -34A | 12:21733 |
| 4084/ 11 | NTIS (US Sales Only), PC A02/MF A01 | | DE87700880 | MN -34A | 12:21734 |
| 4128/ 9 | NTIS (US Sales Only), PC A02/MF A01 | | DE87701398 | MN -34A | 12:21735 |

| Report Number | Availability Source | File Number | Distribution Category | Abstract Number |
|---|---|---|---|---|
| 4131/ 4 | NTIS (US Sales Only), PC A02/MF A01 | DE87700881 | MN -80 | 12:20388 |
| 4144/ 2 | NTIS (US Sales Only), PC A03/MF A01 | DE87700882 | MN -34C | 12:21643 |
| **IAEA-CN-** | | | | |
| 47/ A-III-4 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87005717 | MN -20a | 12:21870 |
| 47/ B-I-5 | *See* DOE/DP/40200-31 | E 1.99: DE87005916 | MN -21 | 12:21972 |
| **IAEA-R-** | | | | |
| 2954-F | NTIS (US Sales Only), PC A03/MF A01 | DE87700883 | MN -38 | 12:20897 |
| 3227-F | NTIS (US Sales Only), PC A02/MF A01 | DE87700884 | MN -25 | 12:20920 |
| 3478-F | NTIS (US Sales Only), PC A03/MF A01 | DE87700885 | MN -37 | 12:20981 |
| 3496-F | NTIS (US Sales Only), PC A03/MF A01 | DE87700886 | MN -37 | 12:20982 |
| 3629-F | NTIS (US Sales Only), PC A05/MF A01 | DE87700887 | MN -16 | 12:20142 |
| 4152-F | NTIS (US Sales Only), PC A03/MF A01 | DE87700888 | MN -71 | 12:20053 |
| **IAEA-TECDOC-** | | | | |
| 389 | NTIS (US Sales Only), PC A08/MF A01 | DE87700890 | MN -71 | 12:20054 |
| **IC-** | | | | |
| 86/ 4 | NTIS (US Sales Only), PC A02/MF A01 | DE87701369 | MN -34D | 12:21566 |
| 86/ 6 | NTIS (US Sales Only), PC A02/MF A01 | DE87701374 | MN -34D | 12:21567 |
| 86/ 8 | NTIS (US Sales Only), PC A02/MF A01 | DE87701358 | MN -34D | 12:21585 |
| 86/ 9 | NTIS (US Sales Only), PC A02/MF A01 | DE87701360 | MN -34D | 12:21586 |
| 86/ 21 | NTIS (US Sales Only), PC A02/MF A01 | DE87701396 | MN -34A | 12:21736 |
| 86/ 25 | NTIS (US Sales Only), PC A02/MF A01 | DE87701397 | MN -34A | 12:21737 |
| 86/ 28 | NTIS (US Sales Only), PC A02/MF A01 | DE87701381 | MN -34A | 12:21429 |
| 86/ 29 | NTIS (US Sales Only), PC A02/MF A01 | DE87701382 | MN -34A | 12:21430 |
| 86/ 46 | NTIS (US Sales Only), PC A02/MF A01 | DE87701357 | MN -34D | 12:21587 |
| 86/ 54 | NTIS (US Sales Only), PC A03/MF A01 | DE87701352 | MN -34D | 12:21781 |
| 86/ 56 | NTIS (US Sales Only), PC A02/MF A01 | DE87701370 | MN -34D | 12:21568 |
| 86/ 57 | NTIS (US Sales Only), PC A03/MF A01 | DE87701371 | MN -34D | 12:21569 |
| 86/ 58 | NTIS (US Sales Only), PC A02/MF A01 | DE87701372 | MN -34D | 12:21570 |
| 86/ 59 | NTIS (US Sales Only), PC A02/MF A01 | DE87701373 | MN -34D | 12:21571 |
| 86/ 60 | NTIS (US Sales Only), PC A02/MF A01 | DE87701375 | MN -34D | 12:21572 |
| 86/ 61 | NTIS (US Sales Only), PC A02/MF A01 | DE87701346 | MN -34D | 12:21782 |
| 86/ 63 | NTIS (US Sales Only), PC A02/MF A01 | DE87701376 | MN -34D | 12:21573 |
| 86/ 65 | NTIS (US Sales Only), PC A02/MF A01 | DE87701377 | MN -34D | 12:21574 |
| 86/ 73 | NTIS (US Sales Only), PC A02/MF A01 | DE87701378 | MN -34D | 12:21575 |
| 86/ 76 | NTIS (US Sales Only), PC A02/MF A01 | DE87701347 | MN -34D | 12:21783 |
| 86/ 77 | NTIS (US Sales Only), PC A03/MF A01 | DE87701388 | MN -34A | 12:21738 |
| 86/ 78 | NTIS (US Sales Only), PC A02/MF A01 | DE87701348 | MN -34D | 12:21784 |
| 86/ 80 | NTIS (US Sales Only), PC A02/MF A01 | DE87701349 | MN -34D | 12:21785 |
| 86/ 81 | NTIS (US Sales Only), PC A02/MF A01 | DE87701379 | MN -34D | 12:21576 |
| 86/ 83 | NTIS (US Sales Only), PC A02/MF A01 | DE87701359 | MN -34D | 12:21588 |
| 86/ 90 | NTIS (US Sales Only), PC A02/MF A01 | DE87701350 | MN -34D | 12:21786 |
| 86/ 91 | NTIS (US Sales Only), PC A02/MF A01 | DE87701391 | MN -34A | 12:21431 |
| 86/ 94 | NTIS (US Sales Only), PC A03/MF A01 | DE87701380 | MN -34D | 12:21577 |
| 86/ 105 | NTIS (US Sales Only), PC A02/MF A01 | DE87701390 | MN -34A | 12:21739 |
| 86/ 106 | NTIS (US Sales Only), PC A02/MF A01 | DE87701354 | MN -34D | 12:21589 |
| 86/ 115 | NTIS (US Sales Only), PC A02/MF A01 | DE87701365 | MN -34D | 12:21578 |
| 86/ 117 | NTIS (US Sales Only), PC A02/MF A01 | DE87701343 | MN -34D | 12:21787 |
| 86/ 119 | NTIS (US Sales Only), PC A02/MF A01 | DE87701383 | MN -34A | 12:21432 |
| 86/ 121 | NTIS (US Sales Only), PC A02/MF A01 | DE87701344 | MN -34D | 12:21788 |
| 86/ 122 | NTIS (US Sales Only), PC A02/MF A01 | DE87701345 | MN -34D | 12:21789 |
| 86/ 123 | NTIS (US Sales Only), PC A02/MF A01 | DE87701366 | MN -34D | 12:21579 |
| 86/ 124 | NTIS (US Sales Only), PC A02/MF A01 | DE87701355 | MN -34D | 12:21590 |
| 86/ 126 | NTIS (US Sales Only), PC A02/MF A01 | DE87701356 | MN -34D | 12:21591 |
| 86/ 130 | NTIS (US Sales Only), PC A02/MF A01 | DE87701392 | MN -34A | 12:21740 |
| 86/ 133 | NTIS (US Sales Only), PC A02/MF A01 | DE87701367 | MN -34D | 12:21580 |
| 86/ 136 | NTIS (US Sales Only), PC A02/MF A01 | DE87701393 | MN -34A | 12:21741 |
| 86/ 138 | NTIS (US Sales Only), PC A02/MF A01 | DE87701368 | MN -34D | 12:21581 |
| 86/ 141 | NTIS (US Sales Only), PC A02/MF A01 | DE87701394 | MN -34A | 12:21742 |
| 86/ 147 | NTIS (US Sales Only), PC A02/MF A01 | DE87701395 | MN -34A | 12:21743 |
| **IDA-P-** | | | | |
| 1875 | *See* AD-A-175216/1/XAB | | | 12:20522 |
| 1902 | *See* AD-A-175219/5/XAB | | | 12:20524 |
| 1966 | *See* AD-A-175217/9/XAB | | | 12:20523 |
| **IFSR-** | | | | |
| 264 | *See* DOE/ET/53088-264 | E 1.99: DE87005522 | MN -20f | 12:21845 |
| 269 | *See* DOE/ET/53088-269 | E 1.99: DE87006344 | MN -20g | 12:21846 |
| **IFVE-** | | | | |
| 85-21 | NTIS (US Sales Only), PC A02/MF A01 | DE87700891 | MN -34D | 12:21497 |
| **IFVE-OEA-** | | | | |
| 85-151 | NTIS (US Sales Only), PC A02/MF A01 | DE87700892 | MN -28 | 12:20956 |
| **IFVE-OEF-** | | | | |
| 85-11 | NTIS (US Sales Only), PC A02/MF A01 | DE87700893 | MN -34A | 12:20832 |
| 85-62 | NTIS (US Sales Only), PC A03/MF A01 | DE87700894 | MN -37 | 12:20983 |
| **IFVE-OEIPK-** | | | | |
| 85-65 | NTIS (US Sales Only), PC A02/MF A01 | DE87700895 | MN -34D | 12:21498 |
| 85-90 | NTIS (US Sales Only), PC A02/MF A01 | DE87700896 | MN -34D | 12:21499 |
| **IFVE-OI-** | | | | |
| 85-103 | NTIS (US Sales Only), PC A02/MF A01 | DE87700897 | MN -28 | 12:20957 |
| **IFVE-OKU-** | | | | |
| 85-53 | NTIS (US Sales Only), PC A02/MF A01 | DE87700898 | MN -28 | 12:20946 |
| **IFVE-OMVT-** | | | | |
| 85-118 | NTIS (US Sales Only), PC A02/MF A01 | DE87700899 | MN -32 | 12:22061 |
| **IFVE-ONF-** | | | | |
| 84-191 | NTIS (US Sales Only), PC A02/MF A01 | DE87700900 | MN -34D | 12:21500 |

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|---|---|---|---|---|
| 85-109 | NTIS (US Sales Only), PC A02/MF A01 | DE87700901 | MN -34D | 12:21501 |
| 85-111 | NTIS (US Sales Only), PC A02/MF A01 | DE87700902 | MN -34D | 12:21529 |
| **IFVE-ONF/FTO/PK-** | | | | |
| 84-109 | NTIS (US Sales Only), PC A02/MF A01 | DE87700903 | MN -34D | 12:21530 |
| **IFVE-OP-** | | | | |
| 85-52 | NTIS (US Sales Only), PC A02/MF A01 | DE87700904 | MN -28 | 12:20958 |
| **IFVE-OP-OEA-** | | | | |
| 85-61 | NTIS (US Sales Only), PC A02/MF A01 | DE87700905 | MN -28 | 12:20959 |
| **IFVE-OP-OKU-** | | | | |
| 85-182 | NTIS (US Sales Only), PC A02/MF A01 | DE87700906 | MN -28 | 12:20960 |
| **IFVE-OTF-** | | | | |
| 85-14 | NTIS (US Sales Only), PC A02/MF A01 | DE87700907 | MN -34D | 12:21531 |
| 85-48 | NTIS (US Sales Only), PC A02/MF A01 | DE87700908 | MN -34D | 12:21532 |
| 85-57 | NTIS (US Sales Only), PC A02/MF A01 | DE87700909 | MN -34D | 12:21533 |
| 85-67 | NTIS (US Sales Only), PC A02/MF A01 | DE87700910 | MN -34D | 12:21502 |
| 85-115 | NTIS (US Sales Only), PC A02/MF A01 | DE87700911 | MN -34D | 12:21790 |
| 85-179 | NTIS (US Sales Only), PC A02/MF A01 | DE87700912 | MN -34D | 12:21534 |
| **IKE-** | | | | |
| 4-123 | NTIS (US Sales Only), PC A06/MF A01 | DE87751290 | MN -80 | 12:20426 |
| **ILE-** | | | | |
| 8508P | NTIS (US Sales Only), PC A02/MF A01 | DE87700913 | MN -20 | 12:21982 |
| 8509P | NTIS (US Sales Only), PC A02/MF A01 | DE87700914 | MN -20 | 12:21871 |
| **INIS-BR-** | | | | |
| 568 | NTIS (US Sales Only), PC A05/MF A01 | DE87700916 | MN -41 | 12:21714 |
| 569 | NTIS (US Sales Only), PC A05/MF A01 | DE87700917 | MN -51 | 12:21115 |
| 571 | NTIS (US Sales Only), PC A07/MF A01 | DE87700919 | MN -4 | 12:20727 |
| 572 | NTIS (US Sales Only), PC A07/MF A01 | DE87700920 | MN -4 | 12:20728 |
| 574 | NTIS (US Sales Only), PC A05/MF A01 | DE87700922 | MN -86 | 12:20047 |
| 575 | NTIS (US Sales Only), PC A09/MF A01 | DE87700923 | MN -51 | 12:20398 |
| 576 | NTIS (US Sales Only), PC A04/MF A01 | DE87700924 | MN -34B | 12:21295 |
| **INIS-mf-** | | | | |
| 4754-No.34 | NTIS (US Sales Only), PC A06/MF A01 | DE87700925 | MN -20 | 12:21872 |
| 10294 | NTIS (US Sales Only), PC A08/MF A01 | DE87751281 | MN -80 | 12:20427 |
| 10295 | NTIS (US Sales Only), PC A18/MF A01 | DE87751263 | MN -47 | 12:20042 |
| 10297 | NTIS (US Sales Only), PC A03/MF A01 | DE87751270 | MN -48 | 12:21229 |
| 10495-Vols.1-2 | NTIS (US Sales Only), PC A21/MF A01 | DE87701491 | MN -2 | 12:22048 |
| 10549 | NTIS (US Sales Only), PC A04/MF A01 | DE87701464 | MN -38 | 12:20428 |
| 10551 | NTIS (US Sales Only), PC A07/MF A01 | DE87700926 | MN -2 | 12:22081 |
| 10562 | NTIS (US Sales Only), PC A05/MF A01 | DE87701463 | MN -48 | 12:21163 |
| 10563 | NTIS (US Sales Only), PC A08/MF A01 | DE87701474 | MN -80 | 12:20392 |
| 10564 | NTIS (US Sales Only), PC A08/MF A01 | DE87701475 | MN -80 | 12:20393 |
| 10565 | NTIS (US Sales Only), PC A04/MF A01 | DE87780085 | MN -34 | 12:21615 |
| 10566 | NTIS (US Sales Only), PC A03/MF A01 | DE87701461 | MN -41 | 12:20429 |
| 10570 | NTIS (US Sales Only), PC A03/MF A01 | DE87701462 | MN -41 | 12:20399 |
| 10571 | NTIS (US Sales Only), PC A07/MF A01 | DE87701477 | MN -78 | 12:20351 |
| 10572 | NTIS (US Sales Only), PC A03/MF A01 | DE87701473 | MN -80 | 12:20389 |
| 10573 | NTIS (US Sales Only), PC A03/MF A01 | DE87701488 | MN -70 | 12:20109 |
| **INIS-SU-** | | | | |
| 378 | NTIS (US Sales Only), PC A04/MF A01 | DE87780101 | MN -34 | 12:21793 |
| 380 | NTIS (US Sales Only), PC A04/MF A01 | DE87780086 | MN -34 | 12:21616 |
| 385 | NTIS (US Sales Only), PC A04/MF A01 | DE87780104 | MN -34 | 12:21434 |
| 386 | NTIS (US Sales Only), PC A04/MF A01 | DE87780087 | MN -34 | 12:21489 |
| 395 | NTIS (US Sales Only), PC A04/MF A01 | DE87780088 | MN -34 | 12:21490 |
| 396 | NTIS (US Sales Only), PC A04/MF A01 | DE87780089 | MN -34 | 12:21491 |
| 398 | NTIS (US Sales Only), PC A05/MF A01 | DE87780090 | MN -34 | 12:21296 |
| 399 | NTIS (US Sales Only), PC A03/MF A01 | DE87780091 | MN -34 | 12:21623 |
| **INP-** | | | | |
| 1228/ AP | NTIS (US Sales Only), PC A05/MF A01 | DE87701490 | MN -32 | 12:22062 |
| **INPE-** | | | | |
| 026-RPE/ 521 | NTIS, PC A02/MF A01 | | | 12:20279 |
| 3797 | NTIS (US Sales Only), PC A03/MF A01 | DE87700927 | MN -37 | 12:20994 |
| 3894 | NTIS (US Sales Only), PC A02/MF A01 | DE87700928 | MN -20 | 12:20746 |
| 3915 | NTIS (US Sales Only), PC A04/MF A01 | DE87700929 | MN -22 | 12:20043 |
| 3977 | NTIS (US Sales Only), PC A03/MF A01 | DE87700930 | MN -20 | 12:21875 |
| 3978 | NTIS (US Sales Only), PC A02/MF A01 | DE87700931 | MN -20 | 12:21876 |
| **INR-** | | | | |
| 1932/ 3/ E/ B | Power System Computer Centre. Mining and Power System Information Department, Palace of Culture and Science, PL-00-901 Warsaw, Poland | | ND -37 | 12:20995 |
| 1949/ 9/ R/ B | Power System Computer Centre. Mining and Power System Information Department, Palace of Culture and Science, PL-00-901 Warsaw, Poland | | ND -80 | 12:20407 |
| 1960/ 9/ R/ B | Power System Computer Centre. Mining and Power System Information Department, Palace of Culture and Science, PL-00-901 Warsaw, Poland | | ND -32 | 12:22063 |
| **INS-** | | | | |
| 562 | NTIS (US Sales Only), PC A02/MF A01 | DE87700932 | MN -28 | 12:20943 |
| 566 | NTIS (US Sales Only), PC A02/MF A01 | DE87700933 | MN -34C | 12:21671 |
| **IPEN-Pub-** | | | | |
| 84 | NTIS (US Sales Only), PC A02/MF A01 | DE87700934 | MN -48 | 12:21164 |
| 86 | NTIS (US Sales Only), PC A02/MF A01 | DE87700935 | MN -37 | 12:20996 |
| 91 | NTIS (US Sales Only), PC A02/MF A01 | DE87700936 | MN -4 | 12:20729 |
| 97 | NTIS (US Sales Only), PC A02/MF A01 | DE87700937 | MN -4 | 12:20802 |
| 98 | NTIS (US Sales Only), PC A02/MF A01 | DE87701399 | MN -34A | 12:21748 |

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|---|---|---|---|---|
| 99 | NTIS (US Sales Only), PC A02/MF A01 | DE87700938 | MN -4 | 12:20730 |
| 101 | NTIS (US Sales Only), PC A02/MF A01 | DE87700939 | MN -4 | 12:20731 |
| 102 | NTIS (US Sales Only), PC A02/MF A01 | DE87700940 | MN -4 | 12:20803 |
| **IPP-** | | | | |
| 2/ 283 | NTIS (US Sales Only), PC A02/MF A01 | DE87751278 | MN -20a | 12:21877 |
| 5/ 6 | NTIS (US Sales Only), PC A02/MF A01 | DE87751279 | MN -20a | 12:21878 |
| 5/ 11 | NTIS (US Sales Only), PC A03/MF A01 | DE87751277 | MN -20f | 12:21879 |
| III/ 110 | NTIS (US Sales Only), PC A07/MF A01 | DE87751274 | MN -20d | 12:21984 |
| **IPP-JET-** | | | | |
| 32 | NTIS (US Sales Only), PC A02/MF A01 | DE87751273 | MN -20d | 12:21991 |
| **IPPJ-** | | | | |
| 743 | NTIS (US Sales Only), PC A02/MF A01 | DE87700941 | MN -20 | 12:21903 |
| 744 | NTIS (US Sales Only), PC A02/MF A01 | DE87700942 | MN -20 | 12:21904 |
| 745 | NTIS (US Sales Only), PC A02/MF A01 | DE87700943 | MN -20 | 12:21905 |
| 746 | NTIS (US Sales Only), PC A02/MF A01 | DE87700944 | MN -20 | 12:21906 |
| 747 | NTIS (US Sales Only), PC A02/MF A01 | DE87700945 | MN -20 | 12:21907 |
| 748 | NTIS (US Sales Only), PC A02/MF A01 | DE87700946 | MN -20 | 12:21908 |
| 749 | NTIS (US Sales Only), PC A02/MF A01 | DE87700947 | MN -20 | 12:21909 |
| 750 | NTIS (US Sales Only), PC A02/MF A01 | DE87700948 | MN -20 | 12:21910 |
| 751 | NTIS (US Sales Only), PC A03/MF A01 | DE87700949 | MN -20 | 12:21911 |
| 752 | NTIS (US Sales Only), PC A03/MF A01 | DE87700950 | MN -20 | 12:21912 |
| 753 | NTIS (US Sales Only), PC A02/MF A01 | DE87700951 | MN -20 | 12:21913 |
| 754 | NTIS (US Sales Only), PC A02/MF A01 | DE87700952 | MN -20 | 12:21914 |
| 755 | NTIS (US Sales Only), PC A02/MF A01 | DE87700953 | MN -20 | 12:21915 |
| 756 | NTIS (US Sales Only), PC A03/MF A01 | DE87700954 | MN -20 | 12:21916 |
| 758 | NTIS (US Sales Only), PC A03/MF A01 | DE87700955 | MN -20 | 12:21917 |
| 759 | NTIS (US Sales Only), PC A03/MF A01 | DE87700956 | MN -20 | 12:21918 |
| 760 | NTIS (US Sales Only), PC A03/MF A01 | DE87700957 | MN -20 | 12:21919 |
| **IPPJ-DT-** | | | | |
| 116 | NTIS (US Sales Only), PC A02/MF A01 | DE87700958 | MN -51 | 12:21123 |
| 117 | NTIS (US Sales Only), PC A03/MF A01 | DE87700959 | MN -32 | 12:22050 |
| 118 | NTIS (US Sales Only), PC A03/MF A01 | DE87700960 | MN -20 | 12:21920 |
| 119 | NTIS (US Sales Only), PC A02/MF A01 | DE87700961 | MN -20 | 12:21992 |
| 121 | NTIS (US Sales Only), PC A05/MF A01 | DE87700962 | MN -20 | 12:21993 |
| **IRD-CNEN-NT-** | | | | |
| 007/ 86 | NTIS (US Sales Only), PC A02/MF A01 | DE87700963 | MN -41 | 12:21203 |
| 008/ 86 | NTIS (US Sales Only), PC A03/MF A01 | DE87700964 | MN -41 | 12:21204 |
| **ISL-CO-** | | | | |
| 41/ 85 | NTIS, PC A04/MF A01 | | | 12:20807 |
| **ISN-** | | | | |
| 85-44 | NTIS (US Sales Only), PC A09/MF A01 | DE87750985 | MN -78 | 12:21505 |
| **ISPO-** | | | | |
| 258 | *See* LA-10827-MS | E 1.99: DE87006303 | STD -15 | 12:20144 |
| **ITEF-** | | | | |
| 5(1985) | NTIS (US Sales Only), PC A04/MF A01 | DE87700965 | MN -34C | 12:21633 |
| 19(1985) | NTIS (US Sales Only), PC A03/MF A01 | DE87700966 | MN -34D | 12:21796 |
| 30(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700967 | MN -34C | 12:21634 |
| 35(1985) | NTIS (US Sales Only), PC A04/MF A01 | DE87700968 | MN -34D | 12:21593 |
| 38(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700969 | MN -34C | 12:21672 |
| 48(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700970 | MN -28 | 12:20961 |
| 60(1984) | NTIS (US Sales Only), PC A02/MF A01 | DE87700971 | MN -34C | 12:21635 |
| 79(1985) | NTIS (US Sales Only), PC A03/MF A01 | DE87700972 | MN -77 | 12:20357 |
| 85(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700973 | MN -37 | 12:20997 |
| 96(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700974 | MN -34C | 12:21636 |
| 110(1985) | NTIS (US Sales Only), PC A04/MF A01 | DE87700975 | MN -28 | 12:20944 |
| 117(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700976 | MN -34D | 12:21506 |
| 122(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700977 | MN -20 | 12:21994 |
| 132(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700978 | MN -37 | 12:20998 |
| 136(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700979 | MN -34D | 12:21507 |
| 144(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700980 | MN -34C | 12:21673 |
| 147(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700981 | MN -37 | 12:20999 |
| 152(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700982 | MN -80 | 12:20378 |
| 163(1984) | NTIS (US Sales Only), PC A02/MF A01 | DE87700983 | MN -34C | 12:21631 |
| **ITEP-** | | | | |
| 37(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700984 | MN -34A | 12:21438 |
| 39(1985) | NTIS (US Sales Only), PC A04/MF A01 | DE87700985 | MN -34D | 12:21594 |
| 60(1985) | NTIS (US Sales Only), PC A03/MF A01 | DE87700986 | MN -34C | 12:21674 |
| 75(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700987 | MN -34D | 12:21595 |
| 77(1985) | NTIS (US Sales Only), PC A03/MF A01 | DE87700988 | MN -34D | 12:21541 |
| 82(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700989 | MN -34D | 12:21542 |
| 84(1985) | NTIS (US Sales Only), PC A03/MF A01 | DE87700990 | MN -34D | 12:21543 |
| 94(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700991 | MN -34D | 12:21596 |
| 128(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700992 | MN -34D | 12:21544 |
| 135(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700993 | MN -34D | 12:21545 |
| 137(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700994 | MN -34D | 12:21597 |
| 141(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700995 | MN -34D | 12:21546 |
| 146(1985) | NTIS (US Sales Only), PC A02/MF A01 | DE87700996 | MN -34D | 12:21598 |
| **ITF-** | | | | |
| 86-23-R | NTIS (US Sales Only), PC A02/MF A01 | DE87700997 | MN -34D | 12:21599 |
| **JACKFAU-** | | | | |
| 86-322-8 | NTIS, PC A05/MF A01; 1 (GPO Dep.) | E 1.99: DE87006265 | MN -92 | 12:20166 |
| **JAERI-** | | | | |
| 1299 | NTIS (US Sales Only), PC A04/MF A01 | DE87700999 | MN -25 | 12:20659 |
| 1301 | NTIS (US Sales Only), PC A06/MF A01 | DE87701000 | MN -32 | 12:22064 |

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| **JAERI-M-** | | | | |
| 85-150 | NTIS (US Sales Only), PC A03/MF A01 | DE87701001 | MN -25 | 12:20660 |
| 85-160 | NTIS (US Sales Only), PC A02/MF A01 | DE87701002 | MN -25 | 12:20661 |
| 85-173 | NTIS (US Sales Only), PC A06/MF A01 | DE87701003 | MN -25 | 12:21921 |
| 85-176 | NTIS (US Sales Only), PC A05/MF A01 | DE87701004 | MN -20 | 12:21995 |
| 85-179 | NTIS (US Sales Only), PC A20/MF A01 | DE87701005 | MN -20 | 12:21996 |
| 85-189 | NTIS (US Sales Only), PC A02/MF A01 | DE87701006 | MN -20 | 12:21997 |
| 85-204 | NTIS (US Sales Only), PC A02/MF A01 | DE87701007 | MN -20 | 12:21998 |
| 85-205 | NTIS (US Sales Only), PC A11/MF A01 | DE87701008 | MN -20 | 12:21999 |
| 85-208 | NTIS (US Sales Only), PC A04/MF A01 | DE87701009 | MN -80 | 12:20390 |
| 85-214 | NTIS (US Sales Only), PC A03/MF A01 | DE87701010 | MN -80 | 12:20396 |
| 85-215 | NTIS (US Sales Only), PC A05/MF A01 | DE87701011 | MN -20 | 12:22000 |
| 85-216 | NTIS (US Sales Only), PC A05/MF A01 | DE87701012 | MN -20 | 12:21922 |
| 85-219 | NTIS (US Sales Only), PC A02/MF A01 | DE87701013 | MN -78 | 12:20432 |
| 85-220 | NTIS (US Sales Only), PC A03/MF A01 | DE87701014 | MN -4 | 12:20662 |
| 86-001 | NTIS (US Sales Only), PC A03/MF A01 | DE87701015 | MN -32 | 12:20116 |
| 86-003 | NTIS (US Sales Only), PC A11/MF A01 | DE87701016 | MN -25 | 12:20550 |
| 86-004 | NTIS (US Sales Only), PC A05/MF A01 | DE87701017 | MN -80 | 12:20379 |
| 86-005 | NTIS (US Sales Only), PC A04/MF A01 | DE87701018 | MN -28 | 12:20962 |
| 86-006 | NTIS (US Sales Only), PC A04/MF A01 | DE87701019 | MN -20 | 12:22001 |
| 86-007 | NTIS (US Sales Only), PC A04/MF A01 | DE87701020 | MN -25 | 12:20408 |
| 86-008 | NTIS (US Sales Only), PC A04/MF A01 | DE87701021 | MN -20 | 12:22002 |
| 86-010 | NTIS (US Sales Only), PC A06/MF A01 | DE87701022 | MN -32 | 12:22065 |
| 86-012 | NTIS (US Sales Only), PC A09/MF A01 | DE87701023 | MN -80 | 12:20409 |
| **JEN-** | | | | |
| 589 | NTIS (US Sales Only), PC A04/MF A01 | DE87701465 | MN -71 | 12:20055 |
| 590 | NTIS (US Sales Only), PC A03/MF A01 | DE87701481 | MN -37 | 12:21000 |
| 591 | NTIS (US Sales Only), PC A03/MF A01 | DE87701486 | MN -37 | 12:21022 |
| **JINR-** | | | | |
| 9-86-12 | NTIS (US Sales Only), PC A02/MF A01 | DE87701468 | MN -28 | 12:20963 |
| 14-85-893 | NTIS (US Sales Only), PC A02/MF A01 | DE87701401 | MN -34A | 12:21749 |
| D-17-84-850-Vol.2 | NTIS (US Sales Only), PC A16/MF A01 | DE87780102 | MN -34 | 12:21831 |
| E-1-86-87 | NTIS (US Sales Only), PC A02/MF A01 | DE87701484 | MN -37 | 12:21001 |
| E-1-86-107 | NTIS (US Sales Only), PC A02/MF A01 | DE87701384 | MN -34A | 12:21439 |
| E-2-85-834 | NTIS (US Sales Only), PC A02/MF A01 | DE87701385 | MN -34A | 12:21440 |
| E-2-86-15 | NTIS (US Sales Only), PC A02/MF A01 | DE87701351 | MN -34D | 12:21797 |
| E-2-86-17 | NTIS (US Sales Only), PC A02/MF A01 | DE87701361 | MN -34D | 12:21600 |
| E-6-85-536 | NTIS (US Sales Only), PC A02/MF A01 | DE87701482 | MN -37 | 12:21002 |
| E-13-86-28 | NTIS (US Sales Only), PC A02/MF A01 | DE87701483 | MN -37 | 12:21003 |
| R-2-86-16 | NTIS (US Sales Only), PC A02/MF A01 | DE87701362 | MN -34D | 12:21601 |
| R-4-85-917 | NTIS (US Sales Only), PC A02/MF A01 | DE87701387 | MN -34A | 12:21441 |
| R-10-85-891 | NTIS (US Sales Only), PC A02/MF A01 | DE87701467 | MN -28 | 12:20964 |
| R-11-85-758 | NTIS (US Sales Only), PC A02/MF A01 | DE87701386 | MN -34A | 12:21442 |
| R-14-85-726 | NTIS (US Sales Only), PC A02/MF A01 | DE87701493 | MN -34A | 12:21750 |
| **Juel-** | | | | |
| 2060 | NTIS (US Sales Only), PC A08/MF A01 | DE87751266 | MN -20d | 12:22003 |
| 2070 | NTIS (US Sales Only), PC A05/MF A01 | DE87751288 | MN -77 | 12:20358 |
| **Juel-Spez-** | | | | |
| 347 | NTIS (US Sales Only), PC A08/MF A01 | DE87751271 | MN -77 | 12:20359 |
| 358 | NTIS (US Sales Only), PC A06/MF A01 | DE87750824 | MN -2 | 12:20459 |
| 363 | NTIS (US Sales Only), PC A15/MF A01 | DE87751292 | MN -37 | 12:21004 |
| **K/TS-** | | | | |
| 11793 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87003310 | MN -38 | 12:20833 |
| 11811 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87005960 | MN -34 | 12:20809 |
| **KAERC-** | | | | |
| 201/ 85 | NTIS (US Sales Only), PC A02/MF A01 | DE87701471 | MN -80 | 12:20380 |
| 202/ 85 | NTIS (US Sales Only), PC A02/MF A01 | DE87701466 | MN -71 | 12:20834 |
| **KFK-** | | | | |
| 4105 | NTIS (US Sales Only), PC A05/MF A01 | DE87751267 | MN -20d | 12:22004 |
| 4142 | NTIS (US Sales Only), PC A02/MF A01 | DE87751276 | MN -21 | 12:22005 |
| 4146 | NTIS (US Sales Only), PC A03/MF A01 | DE87751275 | MN -11 | 12:21107 |
| 4152 | NTIS (US Sales Only), PC A09/MF A01 | DE87751268 | MN -4 | 12:20804 |
| **KFK-PFT-** | | | | |
| 125 | NTIS (US Sales Only), PC A11/MF A01 | DE87751291 | MN -38 | 12:20835 |
| **KFKI-** | | | | |
| 1986-29/ A | NTIS (US Sales Only), PC A02/MF A01 | DE87701363 | MN -34D | 12:21602 |
| 1986-30/ A | NTIS (US Sales Only), PC A02/MF A01 | DE87701353 | MN -34D | 12:21798 |
| 1986-31/ D | NTIS (US Sales Only), PC A03/MF A01 | DE87701389 | MN -34A | 12:21443 |
| 1986-56/ G-J | NTIS (US Sales Only), PC A02/MF A01 | DE87701472 | MN -80 | 12:20356 |
| 1986-63/ G | NTIS (US Sales Only), PC A02/MF A01 | DE87701487 | MN -37 | 12:21023 |
| 1986-66/ M | NTIS (US Sales Only), PC A02/MF A01 | DE87701478 | MN -78 | 12:20397 |
| **KMSF-U-** | | | | |
| 1821 | NTIS, PC A02; 3 | DE87003424 | MN -21 | 12:22006 |
| 1824 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: DE87003425 | MN -21 | 12:22007 |
| **LA-** | | | | |
| 10748 | NTIS, PC A07/MF A01; 1 (GPO Dep.) | E 1.99: DE87006322 | STD -41 | 12:21239 |
| 10827-MS | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: DE87006303 | STD -15 | 12:20144 |
| 10838 | NTIS, PC A04/MF A01; 1 | DE87006320 | STD -15 | 12:20145 |
| 10865-MS | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: DE87006316 | STD -48 | 12:21116 |
| 10883-MS | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: DE87006319 | STD -32 | 12:22066 |
| 10904-MS | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87006325 | STD -34B | 12:21411 |
| 10915-PR | NTIS, PC A07/MF A01; 1 (GPO Dep.) | E 1.99: DE87006311 | STD -34C | 12:21624 |
| 10916-MS | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87006318 | STD -15 | 12:21005 |

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| **LA-UR-** | | | | | |
| 86-3228 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87000155 | MN -34D | 12:21508 |
| 86-3556 | NTIS, PC A02; 3 | | DE87001964 | MN -20d | 12:22008 |
| 86-3916 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87003711 | MN -28 | 12:20945 |
| 86-4135 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87003723 | MN -4 | 12:20747 |
| 86-4336 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87003754 | MN -32 | 12:22067 |
| 86-4382 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87003762 | MN -90 | 12:19927 |
| 87-140 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005106 | MN -34 | 12:22068 |
| 87-183 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005101 | MN -34B | 12:21412 |
| 87-219 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005098 | MN -34C | 12:21625 |
| 87-285 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006075 | MN -34B | 12:21298 |
| 87-358 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87006051 | MN -34B | 12:21299 |
| 87-409 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006054 | MN -34B | 12:21300 |
| 87-519 | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: | DE87006058 | MN -34 | 12:21799 |
| **LAFI-** | | | | | |
| 075 | NTIS (US Sales Only), PC A03/MF A01 | | DE87701342 | MN -34D | 12:21800 |
| **LAL-** | | | | | |
| 86-06 | NTIS (US Sales Only), PC A08/MF A01 | | DE87750988 | MN -34D | 12:21509 |
| **LBL-** | | | | | |
| 17804 | NTIS, PC A06/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006171 | MN -28 | 12:21006 |
| 21641 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87003529 | MN -05 | 12:21111 |
| 22072 | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: | DE87000937 | MN -34D | 12:21675 |
| 22280 | NTIS, PC A10/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006170 | MN -11 | 12:20295 |
| 22317 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87003525 | MN -38 | 12:20855 |
| 22379 | NTIS, PC A09; 3 | | DE87003622 | MN -34C | 12:21626 |
| 22399 | NTIS, PC A11/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006247 | MN -94c | 12:20447 |
| 22457 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87003540 | MN -20 | 12:21923 |
| 22466 | NTIS, PC A10/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006172 | MN -34A | 12:21444 |
| 22470 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87004474 | MN -38 | 12:21801 |
| 22535 | NTIS, PC A12/MF A01; 1 (GPO Dep.) | E 1.99: | DE87004597 | MN -4 | 12:20748 |
| 22663 | NTIS, PC A13/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006140 | MN -90i | 12:21064 |
| 22720 | NTIS, PC A07/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006141 | MN -66a | 12:20291 |
| 22794 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006143 | MN -11 | 12:21263 |
| 22810 | NTIS, PC A02; 3 | | DE87006043 | MN -66a | 12:20292 |
| **LPC-** | | | | | |
| 83-01 | NTIS (US Sales Only), PC A03/MF A01 | | DE87750986 | MN -34D | 12:21547 |
| **LR-** | | | | | |
| 525(AP) M | *See* PB-87-125704/XAB | | | | 12:21066 |
| **M-** | | | | | |
| 194 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006827 | MN -32 | 12:22069 |
| **MIMEO-SER-** | | | | | |
| 1701 | *See* AD-A-174983/7/XAB | | | | 12:21157 |
| **MRC-R-** | | | | | |
| 976 | *See* AD-A-175522/2/XAB | | | | 12:21047 |
| **N-** | | | | | |
| 8-85 | *See* INIS-SU-386 | | DE87780087 | MN -34 | 12:21489 |
| 14-86 | *See* INIS-SU-396 | | DE87780089 | MN -34 | 12:21491 |
| 16-86 | *See* INIS-SU-395 | | DE87780088 | MN -34 | 12:21490 |
| 87-13486 | NTIS, PC A14/MF A01 | | | | 12:20936 |
| 87-13539 | NTIS, PC A07/MF A01 | | | | 12:20634 |
| 87-13540 | NTIS, PC A04/MF A01 | | | | 12:20635 |
| 87-13661 | NTIS, PC A08/MF A01 | | | | 12:20898 |
| 87-13662 | NTIS, PC A02/MF A01 | | | | 12:20899 |
| 87-13704 | NTIS, PC A15/MF A01 | | | | 12:21024 |
| 87-14148 | NTIS, PC A02/MF A01 | | | | 12:21301 |
| 87-14247 | NTIS, PC A12/MF A01 | | | | 12:20900 |
| 87-14247 | NTIS, PC A12/MF A01 | | | | 12:20901 |
| 87-14247 | NTIS, PC A12/MF A01 | | | | 12:20902 |
| 87-14247 | NTIS, PC A12/MF A01 | | | | 12:20903 |
| 87-14247 | NTIS, PC A12/MF A01 | | | | 12:22070 |
| 87-14374 | NTIS, PC A16/MF A01 | | | | 12:20551 |
| 87-14422 | NTIS, PC A03/MF A01 | | | | 12:20370 |
| 87-14424 | NTIS, PC A20/MF A01 | | | | 12:20937 |
| 87-14427 | NTIS, PC A02/MF A01 | | | | 12:20512 |
| 87-14483 | NTIS, PC A02/MF A01 | | | | 12:20552 |
| 87-14518 | NTIS, PC A02/MF A01 | | | | 12:20636 |
| 87-14656 | NTIS, PC A04/MF A01 | | | | 12:20904 |
| 87-15043 | NTIS, PC A10/MF A01 | | | | 12:21302 |
| 87-15136 | NTIS, PC A04/MF A01 | | | | 12:21388 |
| **NAC-** | | | | | |
| 86-01 | NTIS (US Sales Only), PC A03/MF A01 | | DE87701485 | MN -37 | 12:21007 |
| 86-03 | NTIS (US Sales Only), PC A02/MF A01 | | DE87701400 | MN -34A | 12:21751 |
| **NAL-SP-** | | | | | |
| 5 | *See* N-87-14247 | | | | 12:20900 |
| 5 | *See* N-87-14247 | | | | 12:20901 |
| 5 | *See* N-87-14247 | | | | 12:20902 |
| 5 | *See* N-87-14247 | | | | 12:20903 |
| 5 | *See* N-87-14247 | | | | 12:22070 |
| **NAS-** | | | | | |
| 1.15:87311 | *See* N-87-14483 | | | | 12:20552 |
| 1.15:88213 | *See* N-87-13704 | | | | 12:21024 |
| 1.15:88342 | *See* N-87-15043 | | | | 12:21302 |
| 1.15:88819 | *See* N-87-14518 | | | | 12:20636 |
| 1.15:88877 | *See* N-87-14427 | | | | 12:20512 |

| Report Number | Availability Source | File Number | Distribution Category | Abstract Number |
|---|---|---|---|---|
| 1.15:88918 | *See* N-87-14422 | | | 12:20370 |
| 1.15:89274 | *See* N-87-14374 | | | 12:20551 |
| 1.26:174828 | *See* N-87-13661 | | | 12:20898 |
| 1.26:175010 | *See* N-87-13540 | | | 12:20635 |
| 1.26:178950 | *See* N-87-13662 | | | 12:20899 |
| 1.26:178975 | *See* N-87-14424 | | | 12:20937 |
| 1.26:179504 | *See* N-87-13539 | | | 12:20634 |
| 1.26:179541 | *See* N-87-13486 | | | 12:20936 |
| 1.26:179974 | *See* N-87-14148 | | | 12:21301 |
| 1.26:180018 | *See* N-87-15136 | | | 12:21388 |
| **NASA-CR-** | | | | |
| 174828 | *See* N-87-13661 | | | 12:20898 |
| 175010 | *See* N-87-13540 | | | 12:20635 |
| 178950 | *See* N-87-13662 | | | 12:20899 |
| 178975 | *See* N-87-14424 | | | 12:20937 |
| 179504 | *See* N-87-13539 | | | 12:20634 |
| 179541 | *See* N-87-13486 | | | 12:20936 |
| 179974 | *See* N-87-14148 | | | 12:21301 |
| 180018 | *See* N-87-15136 | | | 12:21388 |
| **NASA-TM-** | | | | |
| 87311 | *See* N-87-14483 | | | 12:20552 |
| 88213 | *See* N-87-13704 | | | 12:21024 |
| 88342 | *See* N-87-15043 | | | 12:21302 |
| 88819 | *See* N-87-14518 | | | 12:20636 |
| 88877 | *See* N-87-14427 | | | 12:20512 |
| 88897 | *See* DOE/NASA/33408-1 | E 1.99: DE87004216 | STD -38 | 12:20247 |
| 88918 | *See* N-87-14422 | | | 12:20370 |
| 89274 | *See* N-87-14374 | | | 12:20551 |
| **NIPER-** | | | | |
| 179 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001226 | STD -92a | 12:19973 |
| 222 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: DE87001223 | STD -92b | 12:19986 |
| **NLR-TR-** | | | | |
| 85054-U | *See* N-87-14656 | | | 12:20904 |
| **NP-** | | | | |
| 7751610 | NTIS (US Sales Only), PC A05/MF A01; 1 | DE87751610 | MN -88 | 12:21126 |
| 7751611 | NTIS (US Sales Only), PC A03/MF A01; 1 | DE87751611 | MN -98 | 12:20466 |
| 7751612 | NTIS (US Sales Only), PC A03/MF A01; 1 | DE87751612 | MN -98 | 12:20467 |
| 7751613 | NTIS (US Sales Only), PC A02/MF A01; 1 | DE87751613 | MN -98 | 12:20468 |
| 7751614 | NTIS (US Sales Only), PC A02/MF A01; 1 | DE87751614 | MN -98 | 12:20469 |
| 7751615 | NTIS (US Sales Only), PC A05/MF A01; 1 | DE87751615 | MN -95d | 12:20461 |
| 7751620 | NTIS (US Sales Only), PC A12/MF A01; 1 | DE87751620 | MN -48 | 12:21230 |
| 7751621 | NTIS (US Sales Only), PC A04/MF A01; 1 | DE87751621 | MN -98 | 12:20477 |
| 7770067 | NTIS (US Sales Only), PC A05/MF A01; 1 | DE87770067 | MN -38 | 12:20808 |
| 7770068 | NTIS (US Sales Only), PC A07/MF A01; 1 | DE87770068 | MN -96 | 12:20493 |
| 7770069 | NTIS (US Sales Only), PC A08/MF A01; 1 | DE87770069 | MN -96 | 12:20521 |
| 7770070 | NTIS (US Sales Only), PC A05/MF A01; 1 | DE87770070 | MN -11 | 12:21065 |
| 7770071 | NTIS (US Sales Only), PC A09/MF A01; 1 | DE87770071 | MN -96 | 12:20516 |
| 7770072 | NTIS (US Sales Only), PC A06/MF A01; 1 | DE87770072 | MN -96 | 12:21035 |
| 7770073 | NTIS (US Sales Only), PC A08/MF A01; 1 | DE87770073 | MN -96 | 12:20517 |
| 7770074 | NTIS (US Sales Only), PC A06/MF A01; 1 | DE87770074 | MN -88 | 12:19931 |
| 7770075 | NTIS (US Sales Only), PC A04/MF A01; 1 | DE87770075 | MN -97 | 12:20316 |
| 7900317 | NTIS (US Sales Only), PC A08/MF A01; 1 | DE87900317 | MN -95d | 12:20487 |
| **NRL-MR-** | | | | |
| 5873 | *See* AD-A-175201/3/XAB | | | 12:20811 |
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| **NT-** | | | | |
| 24/ X/ AE | *See* PB-87-127551/XAB | | | 12:21072 |
| **NTB-** | | | | |
| 85-06 | Nagra, Ch-5401 Baden, Switzerland | | ND -70 | 12:20117 |
| 85-08 | NAGRA, Ch-5401 Baden, Switzerland | | ND -70 | 12:20118 |
| 85-13 | NAGRA, Ch-5401 Baden, Switzerland | | ND -70 | 12:20119 |
| 85-15 | NAGRA, Ch-5401 Baden, Switzerland | | ND -70 | 12:20120 |
| 85-27 | NAGRA, Ch-5401 Baden, Switzerland | | ND -70 | 12:20121 |
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| 85-35 | NAGRA, Ch-5401 Baden, Switzerland | | ND -70 | 12:20123 |
| 85-54 | NAGRA, Ch-5401 Baden, Switzerland | | ND -70 | 12:20124 |
| **NTP-** | | | | |
| 81-58 | *See* PB-87-133278/XAB | | | 12:21233 |
| **NTP-TR-** | | | | |
| 310 | *See* PB-87-131678/XAB | | | 12:21232 |
| **NUREG-** | | | | |
| 0837-Vol.6-No.3 | NTIS, PC A10 - GPO; 3 | DE87900536 | MN -41 | 12:20401 |
| **NUREG/CP-** | | | | |
| 0082-Vol.1 | NTIS, PC A22/MF A01 - GPO | TI87005722 | MN -78 | 12:20433 |
| 0082-Vol.2 | NTIS, PC A19/MF A01 - GPO | TI87005805 | MN -78 | 12:20434 |
| 0082-Vol.3 | NTIS, PC A19/MF A01 - GPO | TI87005959 | MN -78 | 12:20435 |
| 0082-Vol.6 | NTIS, PC A18/MF A01 - GPO | TI87005860 | MN -78 | 12:20436 |
| **NUREG/CR-** | | | | |
| 4613 | NTIS, PC A06/MF A01 - GPO | TI87006428 | MN -80 | 12:20371 |
| 4685 | NTIS, PC A03/MF A01 - GP0 | TI87900534 | MN -11 | 12:21269 |
| 4736 | NTIS, PC A03/MF A01 | TI87006796 | MN -86 | 12:20139 |
| 4820 | NTIS, PC A08/MF A01 - GPO | TI87900525 | MN -11 | 12:21109 |

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| **OEIPK-NA-** | | | | |
| 27 | *See* IFVE-85-21 | DE87700891 | MN -34D | 12:21497 |
| **ONERA-RTS-** | | | | |
| 7/ 7104-EY | NTIS, PC A03/MF A01 | | | 12:20938 |
| **ORNL-** | | | | |
| 6239 | NTIS, PC A09/MF A01; 1 (GPO Dep.) | E 1.99: DE87006008 | MN -11 | 12:21120 |
| 6252 | NTIS, PC A14/MF A01; 1 (GPO Dep.) | E 1.99: DE87006023 | STD -41 | 12:22082 |
| 6362 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: DE87006025 | MN -32 | 12:22071 |
| **ORNL/TM-** | | | | |
| 8982 | NTIS, PC A08/MF A01; 1 | DE87005298 | MN -4 | 12:20161 |
| 9670 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87005275 | MN -4 | 12:20733 |
| 10284 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87005281 | STD -4 | 12:20805 |
| 10346 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87005265 | STD -4 | 12:20734 |
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| 87-121257/ XAB | NTIS PC PC E03/MF E01 | | | 12:19990 |
| 87-121729/ XAB | NTIS, PC A07/MF A01 | | | 12:20494 |
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| 87-125233/ XAB | NTIS, PC A02/MF A01 | | | 12:21008 |
| 87-125704/ XAB | NTIS PC PC E04/MF E04 | | | 12:21066 |
| 87-125779/ XAB | NTIS, PC A99/MF E04 | | | 12:21067 |
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| 87-127767/ XAB | NTIS, PC A07/MF A01 | | | 12:21078 |
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| 87-129318/ XAB | NTIS, PC A05/MF A01 | | | 12:21121 |
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| 87-129862/ XAB | NTIS, PC A08/MF A01 | | | 12:19925 |
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| 87-130274/ XAB | NTIS, PC A03/MF A01 | | | 12:21085 |
| 87-130993/ XAB | NTISCP D03 | | | 12:21413 |
| 87-131371/ XAB | NTIS, PC A04/MF A01 | | | 12:20462 |
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| 87-131629/ XAB | NTIS, PC A08/MF A01 | | | 12:21086 |

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| 87-131678/ XAB | NTIS, PC A09/MF A01 | | | | 12:21232 |
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| 87-131736/ XAB | NTIS, PC A05/MF A01 | | | | 12:21133 |
| 87-132338/ XAB | NTIS, PC A03/MF A01 | | | | 12:20475 |
| 87-132817/ XAB | NTIS, PC A07/MF A01 | | | | 12:21088 |
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| 87-133419/ XAB | NTIS PC PC E03/MF E01 | | | | 12:19920 |
| 87-133476/ XAB | NTIS, PC A06/MF A01 | | | | 12:21092 |
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| 87-133575/ XAB | NTIS, PC A05/MF A01 | | | | 12:20488 |
| 87-133674/ XAB | NTIS, PC A14/MF A01 | | | | 12:21201 |
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| 87-133724/ XAB | NTIS PC PC E06/MF E01 | | | | 12:20456 |
| 87-144333/ XAB | NTIS, PC A04/MF A01 | | | | 12:20160 |
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| 84-314R | *See* AD-A-175174/2/XAB | | | | 12:21407 |
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| 4897 | NTIS, PC A08/MF A01; 1 (GPO Dep.) | E 1.99: | DE86010791 | MN -70 | 12:20125 |
| 5852 | *See* NUREG/CR-4613 | | TI87006428 | MN -80 | 12:20371 |
| 5999 | *See* NUREG/CR-4736 | | TI87006796 | MN -86 | 12:20139 |
| 6112 | NTIS, PC A03/MF A01; 1 | | DE87006590 | MN -70 | 12:20138 |
| 6156 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: | DE87006772 | MN -95f | 12:20511 |
| 6157 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006589 | MN -66d | 12:20300 |
| 6181 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: | DE87006809 | MN -95c | 12:20476 |
| **PNL-SA-** | | | | | |
| 13708 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87003307 | MN -4 | 12:20785 |
| 14140 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87003404 | MN -4 | 12:20735 |
| 14175 | NTIS, PC A02; 3 | | DE87006400 | MN -34A | 12:21752 |
| 14216 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: | DE87006435 | MN -70 | 12:20126 |
| 14279 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006436 | MN -70 | 12:20127 |
| 14350 | NTIS, PC A02; 3 | | DE87006431 | MN -85 | 12:20056 |
| 14361 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006403 | MN -48 | 12:21189 |
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| **PPA-T-** | | | | | |
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| **PPPL-** | | | | | |
| 2391 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005626 | STD -20f | 12:21924 |
| 2392 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005627 | STD -20f | 12:21925 |
| 2394 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005628 | STD -20f | 12:22009 |
| 2396 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005612 | STD -20f | 12:21926 |
| 2407 | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: | DE87005616 | STD -20f | 12:21927 |
| **PRI-** | | | | | |
| 108 | *See* SAIC-86/1981 | | DE87005284 | STD -20g | 12:21928 |
| 110 | *See* SAIC-87/1562 | E 1.99: | DE87006729 | STD -20g | 12:21930 |
| **R-** | | | | | |
| 85AEB304 | *See* N-87-13540 | | | | 12:20635 |
| 86AEB511 | *See* N-87-13539 | | | | 12:20634 |
| **RA-** | | | | | |
| 84-158-3 | *See* PB-87-131546/XAB | | | | 12:20463 |
| **RAD-** | | | | | |
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| 3369-AF | *See* AD-A-175600/6/XAB | | | | 12:20527 |
| **REPT-** | | | | | |
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| 408-SMRM-79-0001 | *See* N-87-14374 | | | | 12:20551 |
| 34136F | *See* N-87-14424 | | | | 12:20937 |
| BB0216 | *See* N-87-14424 | | | | 12:20937 |
| **RFP-** | | | | | |
| 3845 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: | DE87005796 | STD -37 | 12:21036 |
| 3914 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005794 | STD -11 | 12:21108 |
| 3915 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005793 | STD -11 | 12:21054 |
| 3956 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006198 | STD -37 | 12:21037 |
| 4091 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: | DE87005657 | MN -15 | 12:20146 |
| **RHO-BW-CR-** | | | | | |
| 154P | NTIS, PC A25; 3 | | DE87006472 | MN -85 | 12:20128 |

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| 87/ 1562 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006729 | STD -20g | 12:21930 |
| **SAND-** | | | | | |
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| 86-1679C | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87003041 | MN -4 | 12:20129 |
| 86-1698C | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87003036 | MN -38 | 12:21038 |
| 86-1730 | NTIS, PC A02/MF A01; 1 | | DE87006789 | MN -38 | 12:20663 |
| 86-1935C | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87005537 | MN -38 | 12:20810 |
| 86-1978C | NTIS, PC A02; 3 | | DE87005067 | MN -62 | 12:20280 |
| 86-2222C | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006900 | MN -71 | 12:20057 |
| 86-2300C | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87003504 | MN -34D | 12:21709 |
| 86-2448C | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87005877 | MN -20c | 12:20638 |
| 86-2453 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87006769 | MN -32 | 12:22073 |
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TH Thailand
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TO Tonga
TR Turkey
TT Trinidad and Tobago
TW Taiwan
TZ United Republic of Tanzania

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UG Uganda
US United States of America (USA)
UY Uruguay

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VE Venezuela
VI Virgin Islands of the United States
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